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CIVIL AVIATION OF THE USSR

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Foreign Technology Division
Wright-Patterson Air Force Base, Ohio

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А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
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З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
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Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

* ye initially, after vowels, and after ъ, ь; e elsewhere. When written as ё in Russian, transliterate as yё or ё. The use of diacritical marks is preferred, but such marks may be omitted when expediency dictates.

CIVIL AVIATION OF USSR

(ON THE 50TH ANNIVERSARY OF FORMATION)

A. F. Aksenov, Doctor of Technical Sciences

On 9 February our country noted a glorious anniversary - 50 years of civil aviation of the USSR.

In the pamphlet A. F. Aksenov tells about the formation and development of civil aviation, about its technical achievements and the prospects for further development.

The pamphlet is designed for a wide circle of readers.

During December of 1972 all progressive humanity noted the 50th anniversary of the formation of the USSR. Appearing at the joint solemn conference of the CC/CPSU, Supreme Soviet of the USSR, and Supreme Soviet of the RSFSR, the General Secretary of the CC/CPSU comrade L. I. Brezhnev said: "In our country the great brotherhood of the people of labor was born and got stronger, united independently of nationality by the generality of class interests and purposes; relations unprecedented in history were formed which we rightfully call the Leninist friendship of peoples".

These words can be especially vividly confirmed in examples of the work of civil aviators and in examples of the development

and formation of civil aviation which on 9 February 1973 noted its 50th anniversary.

Today each union republic has its aviation, its aviation specialists. But in working epics, such as the battle for Uzbekistan cotton, hundreds of aircraft and tens of thousands of aviators of the Ukraine, Belorussia, the Russian Federation, Moldavia, and other republics of the country participate.

The formation and development of civil aviation in the USSR is tightly connected since October 1917 with the Communist Party of the Soviet Union and with the name of Vladimir Ilyich Lenin. The great thinker and statesman who stood at the sources of many branches of industry which now play an enormous role in the national economy of our country, V. I. Lenin with the sagacity inherent to him predicted the great future of civil aviation and did much for its development.

Our country became a great aviation power. The civil aviation of the USSR is not only passenger transportation. Airplanes and helicopters transport hundreds of thousands of tons of various cargo and mail. They deliver various equipment to builders and oil-industry workers, fresh vegetables and fruits from the south of the country to the inhabitants of Siberia, the Far East, and the extreme north. Daily approximately 100 aircraft take from Moscow to dozens of cities more than 300 matrix assemblies of central newspapers and journals.

In our time it is difficult to find a branch of the national economy where aviation is not used. It actively affects the development of industry, agriculture, and science and contributes to an increase in the standard of living of the Soviet people and to an improvement in maintaining their way of life. Civil aviation of the USSR notes its 50th anniversary. Fifty years

is a short period for history but during this period, because of the wise leadership of the Leninist party and the creativity and heroic work of the Soviet people, a new branch of the national economy of the country was created - civil aviation - which has at its disposal first-class technology and highly skilled specialists.

A SHORT HISTORY

The first days of the Republic of Soviets saw the first concerns for the creation of a domestic air fleet. On the initiative of V. I. Lenin aviation control agencies were created, tedious work on recruitment and instruction of personnel was carried out, the production and repair of aircraft were set up, and on this basis the first aviation links were organized. On 28 October 1917 at the Military Revolutionary Committee the Office of Commissars of Aviation and Aeronautics was created. On 20 December of 1917 the All-Russian Aviation Board on Control of the Air Fleet of the Republic was formed. On 24 May 1918 the Chief Directorate of the Air Fleet ("Glavvozdukhput'") was organized. In only two years - 1918 and 1919 - more than 200 documents on aviation were signed by V. I. Lenin which history carefully preserves.

Even in the years of the civil war, aircraft were utilized as transport means for special occasional transportation of mail and urgent cargos for military parts, transport flights were accomplished in Central Asia, in central sectors of the front, from Moscow to Kharkov, etc.

During December of 1919 the Commission on Heavy Aircraft ("КОМТа") was created - the prototype of aviation scientific research and design organizations.

The first state act regulating air communications in our country was signed in January of 1921 by V. I. Lenin, decree

of the Council of People's Commissars (SNK) of the RSFSR "about air movements in the air space above the territory of the RSFSR and above its territorial waters".

On 9 February 1923 attached to the government of the USSR was instituted the Council on Civil Aviation which approached the realization of the three year tentative plan approved by the Council of Labor and Defense for the development of an air fleet. This date is considered the birth day of civil aviation in our country. Thus the beginning to an organized and systematic building of air transportation was authorized.

For an improvement in the operation of air communications in 1923 three joint-stock societies were created: "Russian Society of the Voluntary Air Fleet" ("Dobrolet"), "Ukrainian Society of Air Communications" ("Ukrvozdukhput'") and "Transcaucasian Society of the Air Fleet" ("Zakavia"). Many Soviet state and public organizations, and also workers of our country became shareholders of these societies. On their resources the aircraft and necessary equipment were bought. Wide participation in the joint-stock societies of the air fleet by domestic organizations and the population immediately gave the matter of the development of civil aviation in our country mass character and national value. "The Society of Friends of the Air Fleet" (ODVF) created at the same time on V. I. Lenin's instructions played a large role in the development of civil aviation. V. I. Lenin and N. K. Krupskaya entered the society among the first. M. I. Kalinin, V. V. Kuibyshev, S. M. Kirov, and G. K. Ordzhonikidze accepted active participation in the organization ODVF. In the managing staff of ODVF were chosen M. V. Frunze, F. E. Dzerzhinskii, K. Ye. Voroshilov, S. A. Chaplygin, and A. N. Tupolev. In 1923 was opened the first internal routine line Moscow - Nizhniy Novgorod 420 km in extent, on which during the year 229

passengers and 1900 kg of mail and cargo were transported. The effect and the social and political resonance of the first air route at that time were very great, since it opened a whole epoch of the building of routine air communications of our homeland.

On 8 February 1924 the first-born of the civil aviation of the Soviet Nation three-seater passenger aircraft AK-1 (figure 1) of designers V. A. Aleksandrov and V. V. Kalinin swept up into the air. In 1925 this aircraft participated in long distance flight on the route Moscow-Peking.

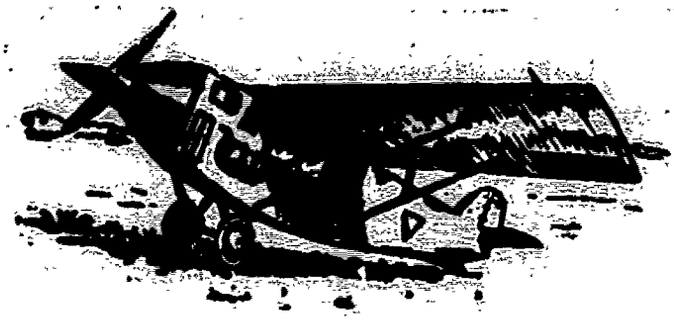

Figure 1. First domestic passenger aircraft AK-1.

The "ANT" aircraft were created by the design collective headed by A. N. Tupolev. In 1924 the aircraft ANT-2 appeared and then the aircraft ANT-4 "Soviet Nation", in which pilot S. A. Shestakov in 1929 completed the outstanding flight on the route Moscow - New York, 21,242 km in total extent in 142 flying hours.

In 1925 the aircraft ANT-6 was created, while in 1929 the three-engined, nine passenger, aircraft ANT-9 - "Wings of the Soviets" was created. Subsequently, pilot M. M. Gromov completed in this aircraft the well-known flight through Europe; a distance of 9037 km was covered in 53 flying hours. These flights demonstrated the high qualities of domestic aircraft and the skill of the pilots.

YEARS OF THE FIRST FIVE-YEAR PLANS

The first five-year plan was 1929-1933. The country took a course toward socialist industrialization. In these years new branches of industry were created, including the aircraft industry. Soviet designers designed new aircraft types and engines which according to their aviation engineering data were not inferior to the best foreign samples.

The years of the first five-year plan for Aeroflot and all the subsequent years of prewar five-year plans are characterized by wide building of new and reconstruction of existing lines, by a rapid increase in the rate of flights, by an increase in the volume of aviation transportations, by the building of airports, repair plants, and shops, and the organization of educational institutions.

On the lines of the Civil Air Fleet appeared the then new passenger aircraft of domestic production - PS-9, PS-40, Stal'-2, K-5, postal aircraft P-5, aircraft PO-2 and others.

In 1930-1931 the aircraft ANT-14 - "Pravda" was built with 36 passenger places, while in 1934 was created the world's largest eight-engine giant aircraft ANT-20 "Maxim Gor'kiy", designed for 70 passengers. These aircraft were then part of the propaganda squadron in M. Gorikiy's name.

In February 1933, in connection with the tenth anniversary of the organization of the Council on Civil Aviation, the eminent distinguished figure of the Communist party and Soviet state V. V. Kuibyshev said: "The successes of civil aviation are a link in the total chain of development of our national economy.... We created such fields of production as pre-revolutionary Russia, did not know and aviation is a bright example of this new field".

Soviet pilots established new records in domestic aircraft which glorified our country, increased the transportation of passengers and cargo, and mastered the almost inaccessible areas of the country. Toward the end of the first five-year plan the extent of air routes exceeded 32 thous. km, in the period of the first five-year plan 82 thous. passengers and 2000 t of mail and cargo were transported.

The country, not having domestic aircraft construction before the revolution, at the beginning of the second five-year plan became a foremost aviation power. Noting the great successes of Soviet aviation in the first five-year plan, the Council of Peoples' Commissars of the USSR on 28 April 1933 established the yearly celebration of Air Fleet of the USSR Day. The first holiday took place on 18 August 1933.

In connection with the development of the national economy, and accordingly also of the Civil Air Fleet, in 1930 the voluntary societies were reorganized into a single organization - the All-Union Association of the Civil Air Fleet - attached to the Council of Labor and Defense of the USSR.

In February of 1932 this association was converted to the Main Administration of the Civil Air Fleet (Aeroflot) attached to the government of the USSR. During this period the territorial Directorates of the GVF (Civil Air Fleet) began to be organized.

The Civil Air Fleet developed at an even higher rate in the second and third five-year plans. At this time the industry began to turn out for Aeroflot new aircraft of the designers A. Tupolev, A. Arkhangel'skiy, N. Polikarpov, A. Kalinin, S. Ilyushin et al. (Stal'-3, G-2, PS-7, PR-5, PS-39, PS-35, and others). Moreover the aircraft PS-39, Stal'-2, and Stal'-3 were designed and constructed at Aeroflot plants. The majority of

aircraft were equipped with engines designed by V. Klimov, A. Shvetsov, A. Mikulin, and S. Tumanskiy.

The history of these years is significant for the unprecedented scope of mass heroism of the Soviet pilots and for the building of the largest air ships in the world.

In 1934 domestic aircraft participated in the rescue of the crew of the steamship "Chelyuskin" in the Arctic Ocean. After this feat the pilots V. Molokov, N. Kamanin, S. Levanevskiy, A. Lyapidevskiy, M. Slepnev, M. Vodop'yanov, and I. Doronin were the USSR's first to be awarded the title of Hero of the Soviet Union.

In ANT-6 aircraft pilots M. Vodop'yanov, A. Alekseyev, I. Mazuruk, and V. Molokov in 1937 set down the first scientific expedition at the North Pole. In the same year the crew composed of V. Chkalov, A. Belyakov, G. Baydukov, and a month later the crew composed of M. Gromov, A. Yumashev, S. Danilin in an ANT-25 aircraft completed the unforgettable flights from Moscow over the North Pole to America. In the history of aviation are inscribed the heroic flights of the famous pilots: V. Kokkinaki to America, V. Grizodubovoy, P. Osipenko and M. Raskovoy from Moscow to the Far East.

In pre-war years 62 world aviation records belonged to the Soviet Union. The results of the second five-year plan showed the following: if the carrying capacity of Soviet transport aviation in 1933 was 3.1 million t-km, then in 1938 it achieved 31.7 million t-km, which composes an increase of 1022.6%. By the beginning of 1939 the extent of air routes had increased to 138 thousand km.

In the first three and a half years of the third five-year plan the Civil Air Fleet attained new large successes in technical

equipment and an increase in the volume of air transportations, and also in the work of special use aviation.

Considerable attention was given to the development of lines in the industrial areas of the country, in national, union, and autonomous republics, krays and oblast's, in the areas of the extreme north, where the railroad network was absent or was weakly developed where air transportation served as the only means of delivery of mail, cargo, transportation of passengers, and rendering medical aid to the population.

WAR YEARS

War, imposed on the Soviet Union by Fascist Germany, hindered the further execution of the third five-year plan. The Soviet people rose to the protection of its freedom and independence.

New problems in connection with the military situation arose before the Civil Air Fleet. The main part of the powered aircraft fleet and aviation engineering personnel directly participated in military actions. In aircraft at the front and in partisan forces they delivered armament, ammunition, drugs, and preserved blood, transported wounded, and dispersed leaflets in the territory temporarily occupied by the enemy. Transport aviation supported constant communication with the hero cities: Leningrad, Sevastopol', Odessa, Stalingrad, and Kiev. In the rear areas of the country civil aviation serviced first of all the defense industry.

In the years of the Great Patriotic War the personnel of the civil aviation showed numerous examples of courage, selfless actions, and selfless devotion to the homeland. During the war the pilots of GVF flew more than 4.5 million hours. The main work on the maintenance of front units and partisan forces was made by night.

Pilots of the GVF transported more than 1620 thous. passengers, approximately 225 thous. t of military cargo, completed 40,000 flights in the enemy's rear, and dropped there 900 t of leaflets.

The Soviet government highly valued the combat service at the war fronts and the selfless work in the rear of the civil aviation workers. Thousands of pilots, navigators, flight mechanics, radio operators, engineers, technicians, workers, and employees were awarded orders and medals. Ten units were awarded government rewards, honorary names and guard titles. To many pilots is appropriated the title of Hero of the Soviet Union. These are G. Taran, P. Yeromasov, P. Mikhaylov, D. Yezerskiy, A. Shornikov, F. Radugii, B. Lakhtin, V. Pavlov, I. Ryshkov, V. Shipilov, P. Yakimov, S. Frolovskiy, A. Gruzdin, P. Koshuba, B. Kalinkin.

AGAIN IN PEACEFUL SKIES

After the war the civil air fleet rapidly changed over to the maintenance of peaceful socialist building and obtained even greater development. Even in 1945 on the lines of the USSR two times more passengers and cargo were transported than in prewar 1940.

In the fourth five-year plan (1946-1950) the airports and other objects destroyed during the war were restored and new building was conducted. The extent of aviation routes reached 175 thous. km, moreover the assignment for the development of the air network was executed a year earlier than the planned date. The technical equipment of the Civil Air Fleet increased considerably. The new twin-engined passenger aircraft Il-12 designed by S. Ilyushin entered into operation. There was an increase in the number of airports equipped to land and launch aircraft under complex meteorological conditions and at night.

The volume of transportations exceeded the 1940 level more than six times, the total volume of the works of special use aviation exceeded the prewar level 4 times.

During the years of the fourth five-year plan the network of international lines was considerably expanded.

The XIX Party Congress in instructions on the fifth five-year plan set the task to considerably increase the fleet of transport aircraft of the GVF, and also the network of lines and airports equipped for 24-hour work, and to increase the volume of transportations two times in comparison with the fourth five-year plan.

As a result of the execution of these assignments of the Party the extent of air lines increased considerably. The freight turnover of air transport increased 85% and there was an increase in the number of airports equipped for 24-hour work.

The powered aircraft fleet was supplemented by new aviation technology. The twin-engined aircraft Il-14 designed by S. Ilyushin entered into operation. The An-2 aircraft designed by O. Antonov occupied an important place on the local lines and in special use aviation. The Yak-12 aircraft designed by A. Yakovlev began to be utilized on works in special use aviation. The first jet aircraft designed by S. Ilyushin also entered operation, on which were accomplished mail flights on the route Moscow - Novosibirsk. Flights on these aircraft made it possible to accumulate jet technology operating experience.

A qualitative jump which marked the beginning of a technical revolution in aviation occurred in the mid 50's when the powerful and light jet engine appeared as a replacement for the piston engine. Aircraft with jet engines considerably exceeded all

parameters and technical and economical indices of piston-engined aircraft and first of all in speed and carrying capacity. Jet technology opened before air transport new, previously unprecedented prospects for an increase in air transportations. If before the appearance of jet aircraft in 1955 2.5 million people were transported on the lines of the USSR, then as long ago as 1958 the number of transported passengers exceeded 8 million people.

The first passenger aircraft of jet aviation designed by A. Tupolev, the Tu-104, after completing its first flight with passengers on the route Moscow - Irkutsk on 15 September 1956 became the basic aircraft on the trunk lines of Aeroflot. Its flying speed was 800-900 km/h, the number of transportable passengers up to 100. In 1957-1959 the passenger aircraft Tu-114, Il-18, An-10, and An-24 appeared created by the design collectives under the guidance of A. Tupolev, S. Ilyushin, O. Antonov.

In the beginning of the 50's the helicopters designed by M. Mil (Mi -1, Mi -4), and N. Kamov (Ka-15, Ka-18) received wide application in the national economy.

During the years of the sixth five-year plan the extent of the air routes of Aeroflot increased from 321.5 thous. km in 1955 to 355.4 thous. km in 1959, and the transportation of passengers increased from 2.5 million to 12.3 million people respectively.

In the last seven year period the progress of civil aviation was achieved at unprecedented high rates. The extent of lines increased to 500 thous. km, aircraft and helicopters connected more than 3500 populated points, in the last year of the seven year plan the aircraft of Aeroflot lifted daily into the air up to 300 thous. people, and its pilots flew 150 million km - the distance from Earth to the sun, the quantity of transported

passengers in 1965 reached 42 million. Transportations of mail and cargo increased substantially. Aviation rendered essential aid to agriculture, geologists, fishermen, and scientists.

The air fleet was supplemented by new aircraft Tu-124, Tu-134, Il-62, Yak-40, etc., and by helicopters Ka-26, Mi -8, and Mi -10.

More than 90 airports were reconstructed or newly built, lines were equipped with modern means of air navigation and radio equipment.

The specific weight of transportations on aircraft with jet engines (relative to total volume in kilometer-tons) continued to build up from 32.7 in 1959 to 81.2% in 1965.

After achievement in the mastery of aviation technology and the maintenance of the national economy of the country the Civil Air Fleet on the day of its fortieth anniversary on 9 February 1963 by Decree of the Presidium of the Supreme Soviet of the USSR was awarded the highest award of the country - the Order of Lenin. The title of Hero of Socialist Labor was confered on a large group of Aeroflot workers, the title of Distinguished Pilot of the USSR and Distinguished Navigator of the USSR was confered on many aviators. During the successful execution of the seven-year plan 1548 people are awarded orders and medals.

In the directives of the XXIII Congress of the CPSU on the five-year plan for the development of the national economy of the USSR in 1966-1970 was marked out a further increase in transportations of passengers by air transport of approximately 1.8 times. On lines of national significance construction of 35-40 airports of national significance and 200 on the local lines was envisaged. The airports on the main lines of national significance were due to be equipped with modern radio equipment for

the direction of aircraft and with automatic approach control systems. A wide program planned by the five-year plan for the development of Aeroflot was successfully executed. In the period 1960-1970 the stable foundation of a new powerful technical base of civil aviation was laid: jet technology became the leader in air transport, the specific weight of transportations on aircraft with gas turbine engines approached 100%. If the middle of the 50's was significant for civil aviation by change to jet technology, then the 70's will signify a change to supersonic technology.

The historic XXIV Congress of the CPSU placed before aviators the task of assimilation of new high-speed, economical aircraft including supersonic aircraft. In the ninth five-year plan work volumes will be increased 1.7 times. The development of air routes, airports, aircraft, and helicopters should be based on the newest achievements of science and engineering. Because of the implementation of computer technology and means of complex mechanization and automation of production processes the organization of air movements and passenger service will be considerably improved. For the solution of these problems the network of scientific research institutions will be expanded and the quality of the carried out scientific investigations will be raised.

AEROFLOT IN THE TRANSPORTATION SYSTEM OF THE COUNTRY

The most important condition for decrease in the expenditures of public work during the accomplishment of cargo and passenger transportations is the economicly advisable distribution of sphere and volume of work between the different forms of transportation.

Each form of transportation (railroad, sea, river, automotive, and air) has its most advantageous fields of application. Their

advisability is caused by a large quantity of factors which can be united in three basic groups: physicogeographical, technical-operational, and economic.

Speed of transport means is related to one of the important indices which makes it possible to compare the technical and economical characteristics of the different forms of transportation.

The speeds given in the table 1 may be considered the most probable for standard means of transportation.

Table 1. Comparison of the speeds of different means of communication.

Means of service	Speed, km/h	Means of service	Speed, km/h
Turbojet aircraft	750-850	Interurban bus	60-70
Turboprop aircraft	550-650	Truck	25-30
Piston aircraft	200-250	Hydrofoil ship	70-75
Helicopter	120-150	Marine motor ship	30-40
Express train	70-100	River motor ship	20-25
Freight train	30-35	Passenger automobile	60-70

As is evident, the important advantage of air transport in comparison with other forms of transportation is the high speed of transportations which ensures considerable savings of public time. This savings is the most important criterion of the national-economic effectiveness of air transport.

The advantages of air transport in high-speed communication determined its rate of development. If in 1970 passenger traffic of all forms of general use transportation in interurban service grew in comparison with 1950 4.5 times, railroad - 2.9 times, then air traffic grew 65 times!

The change in the role of the different forms of transportation in passenger traffic service of the country in 1950-1970 is given in Table 2.

Table 2. Specific weight of individual types of transportation in total passenger traffic in international service.

Year	All forms of transportation	Including				
		railroad	sea	river	automotive (general use buses)	air
1950	100	91.1	1.6	3.8	1.9	1.6
1955	100	89.1	1.2	2.9	4.5	2.3
1960	100	79.5	0.8	2.6	9.7	7.4
1965	100	66.9	0.7	2.2	13.2	17.0
1966	100	66.0	0.6	2.1	13.2	18.1
1967	100	64.4	0.6	1.9	13.4	19.7
1968	100	63.3	0.6	1.8	13.5	20.8
1969	100	61.4	0.5	1.7	13.6	22.8
1970	100	59.1	0.5	1.6	14.9	23.9

As is evident from table 2, the specific weight of air transport in total passenger traffic in interurban service steadily increases.

In accordance with the directives of the XXIV Congress of the CPSU in the current five-year plan the further development of air transport is envisaged to satisfy the growing necessities of the population and the national economy for aviation transportations. Air passenger traffic will increase in 1975 1.7 times in comparison with 1970 and will reach 133 billion passenger-km. In connection with this, the specific weight of air transport in total passenger traffic will comprise in 1975 29% of all forms of general use transportation.

The total extent of the lines operated by Aeroflot composed in 1972 773 thous. km, including international lines - 225 thous. km (figure 2).

The technical reconstruction of air transportation (especially after the introduction of gas-turbine aircraft) conditioned considerable changes in the distribution of passenger transportations between railroad and aviation transport (table 3).

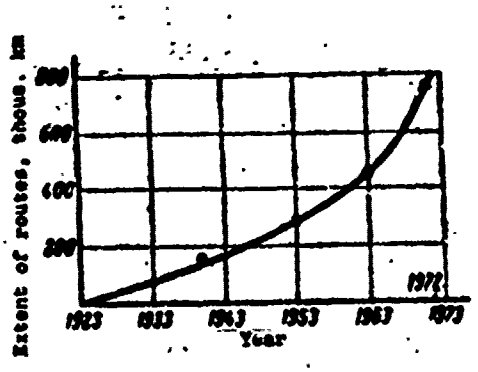

Figure 2. Extent of air lines.

Table 3. Passenger transportations by air and railroad transport in long-distance service.

Year	Passenger traffic, billions of pass-km		Fraction of air transport in the total passenger traffic, %	Transportations of passengers, mln		Fraction of air transport in total transportations, %
	air transport	long-distance railroad transport		air transport	long-distance railroad transport	
1950	1.2	66.8	1.8	1.5	209	0.7
1955	2.8	109.1	2.5	2.5	249	1.0
1960	12.1	130.1	8.5	16.0	237	6.3
1965	38.1	150.0	20.3	42.1	252	14.3
1966	45.1	164.0	21.6	47.2	279	14.5
1967	53.5	174.6	23.5	55.1	297	15.6
1968	62.1	188.8	24.8	60.7	305	16.6
1969	71.5	192.8	27.1	68.0	311	17.9
1970	78.2	193.6	28.8	71.4	314	18.5

The fraction of air transport in total passenger traffic (in long-distance service) increased from 1.8% in 1950, to 28.8% in 1970, and in total transportations of passengers it increased from 0.7% to 18.5% respectively. In 1975 according to approximate calculations the fraction of air transport in the total passenger traffic will increase to 37%, in the total transportations of passengers it will increase to 24%.

Along certain main lines air transport became the basic form of passenger transportation (table 4).

Table 4. Transportations of passengers during August of 1970 by air and railroad transports along certain routes.

Route	Total passenger traffic*, thous. people	Including		Fractional share, %	
		air transport	railroad transport	air transport	railroad transport
Moscow - Khabarovsk	27.8	25.0	2.8	89.9	10.1
Moscow - Irkutsk	20.0	13.5	6.5	67.5	32.5
Moscow - Novosibirsk	27.1	16.6	10.5	61.3	38.7
Moscow - Sverdlovsk	42.8	24.6	18.2	57.5	42.5
Moscow - Alma-Ata	19.5	14.1	5.4	72.3	27.7
Moscow - Tashkent	43.5	26.6	16.9	61.1	38.9
Moscow - Baku	42.4	28.4	14.0	67.0	33.0
Moscow - Ashkhabad	10.2	8.7	1.5	85.3	14.7
Moscow - Tbilisi	41.2	29.9	11.3	72.6	27.4
Moscow - Sochi	151.2	91.4	59.8	60.4	39.6
Moscow - Simferopol'	162.8	81.5	81.3	50.1	49.9
Sverdlovsk - Tashkent	10.2	8.6	1.6	84.3	15.7
Kiev - Sochi	39.9	32.3	7.6	81.0	19.0

*Original round trip departures (without transit).

Using air transport, the population of our country saved approximately 78 million man-days in 1971. In all from the day of its founding, i.e. from 1923 to 1972, civil aviation transported more than 700 million passengers (figure 3). It is not difficult to imagine how much publically useful time air transport saved and what immense material values were produced during this saved time.

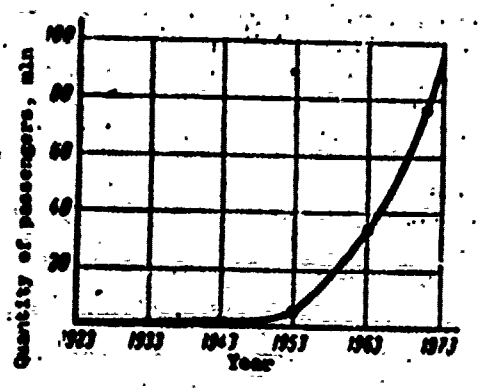

Figure 3. Transportations of passengers on the lines of Aeroflot.

Civil aviation also transports many hundreds of thousands of tons of mail and cargo yearly (figure 4). Timely and safe delivery of cargo ensures the execution of the state plan for supply and commodity circulation, and mail delivery ensures business, cultural, and personal communications in the country. Cargo transportations on air transport occupy an insignificant specific weight (0.05%) in the total volume of freight traffic of the entire transportation system of the country, but all the same their commodity value is expressed in millions of roubles. Moreover, one ought to especially consider the national-economic importance of aviation cargoes which in the majority are top priority.

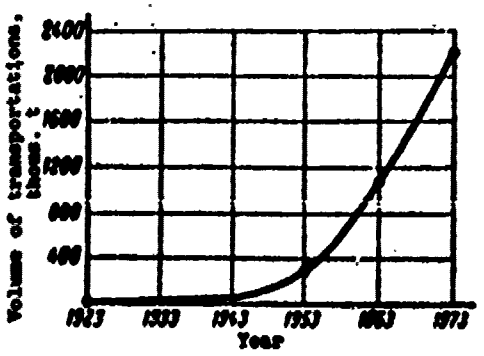

Figure 4. Increase in the volume of transportations of mail and cargo.

The work of civil aviation on the transportation of cargo and mail contributes to a rapid turnover of material assets and to an increase in socialist profits. But if we speak about the transportation of the individual categories of loads, then here civil aviation occupies a monopolistic position not only in localities weakly covered by surface transportation, but also in areas saturated by railroads.

The high national economic effectiveness of air transport consists also in the fact that, taking on itself a considerable part of the passenger transportations, air transport creates the possibility of railroad transport reducing the quantity of passenger trains and increasing cargo motion and freight traffic in the country, which also has important national value.

In the course of the building of communism transportation, including air, becomes an ever more powerful factor accelerating the development of productive forces and the creation of the material and technical base of communism, and facilitating the further wide social division of labor and increase in its productivity. Air transportation becomes an inseparable part and the very material and technical base of communism, completely retaining its functions as part of the independent fourth sphere of material production.

Aviation - An Active Participant in the National Economic Development of the Country

At the Rostov Ball Bearing Plant 27 ventilation shafts each of which weighed more than 4 t were to be installed. Calculations showed that their installation would occupy more than 80 days. The plan for putting the shafts into operation was upset. Then it was decided to turn to helicopter pilots for aid. With maximum precaution they carried these constructions above the building, lowered them with great care into the aperture of the roof to a four-meter depth and accurately installed them on the foundation. The entire operation occupied approximately 7 hours.

In a distant taiga village of Krasnoyarsk Krey a misfortune occured. A man became seriously ill. Urgent surgical intervention was required and the nearest hospital was far away. And then from the Krasnoyarsk airport an aircraft equipped with everything necessary for conducting the operation flew out.

A brief but difficult flight above the taiga through a thunderstorm front. Landing.... The complex operation lasted several hours, and death retreated. The man was saved.

It is difficult to imagine the national economy of the country without the winged assistants. Aviation has solidly entered its panorama. It actively affects the development of industry and agriculture, contributes to an increase in the standard of living of the Soviet people, to an improvement in their way of life and medical maintenance; with its aid transportation problems and problems of science, construction, and protection of natural resources are solved.

The aviators became the reliable assistants and friends of the geologists and fishermen, weather forecasters and scientists. They lead vessels through the Northern Sea Route and service the drifting polar stations, they lay gas pipe lines under severe roadless conditions, they establish electrical transmission lines in the almost inaccessible areas of the country, fight agricultural pests, protect the forests from fires, and with the Red Cross on board hurry to the aid of sick and injured.

Thought about the use of aviation in the national economy was expressed for the first time by V. I. Lenin. In his recollections about meetings with Vladimir Ilyich one of the members of the All-Russian Board on the Control of the Air Fleet of the young Soviet republic, pilot M. P. Stroyev, writes: "Vladimir Ilyich with his inherent energy attacked those who attempted to

sow the conviction that we do not need aviation. He hotly and confidently said that socialist Russia should have its air fleet and that it is necessary to utilize aviation in the national economy[1]. In the first months of the existence of the young Soviet republic during April 1918, on V. I. Lenin's indication a division for use of aviation in the national economy was created attached to the All-Russian Commission for Control of the Air Fleet, under the guidance of which research was initiated on the possibilities of using aviation in agriculture. In 1925 and 1926 experimental expeditions were established by the People's Commissariat of Agriculture of the RSFSR which conducted the first works on the use of aviation for fighting agricultural plant pests.

The advantages of the socialist production method over the capitalist method make it possible to use aviation extensively in the interests of the development of agriculture. In volume of airborne agricultural chemical operations the Soviet Union occupies at present the first place in the world.

Aviation is widely utilized in various agricultural works. In 1970 airplanes and helicopters carried out 41.7% of the total volume of chemical application operations in agriculture and treated more than 34% of the cultivated areas of the country. At present in the USSR the process of equipping agriculture with airborne equipment essentially continues.

The use of aviation instead of ground-based machines in the application of chemicals eliminates the packing of soil and the destruction of its structure and also mechanical damage to plants

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[1]M. P. Stroyev. Conversations with V. I. Lenin About the Building of Soviet Aviation. - "Herald of the Air Fleet", 1957, No. 4.

and makes it possible to carry out agricultural operations independently of the vegetative stage of the plants and the surface condition of the soil without crop damage. Airplanes and helicopters can carry out the treatment of crops and plantings in places almost inaccessible and completely inaccessible for ground-based equipment. Therefore, with the aid of aviation it is possible to mechanize agricultural operations in areas where it is not possible to utilize ground-based equipment.

Possessing high productivity, airplanes and helicopters carry out chemical operations at the concise most optimum agrotechnical periods, which contributes to an increase in the total yield of agricultural crops.

Aviation plays an important role in cotton growing, sugar-beet raising and grain production. With every year aviation exerts an increasing influence on increase in the total yield of the production of agriculture in our country and allows kolkhozes and state farms with less expenditures to obtain more production from a unit of earth area, thus promoting further intensification of agricultural production.

The use of aviation in agriculture increases the power available for agricultural labor and the power base of kolkhozes and state farms, saves ground-based equipment resources, and contributes to improvement in its use. Wide application of aviation technology increases the level of mechanization of agricultural production and introduces new qualitative shifts to mechanization. Use of airplanes and helicopters in conjunction with ground-based equipment opens new possibilities for the creation of a more ideal system of machines for the complex mechanization of kolkhoz-state farm production and leads to the industrialization of agriculture and increases the productivity of agricultural labor.

Use of aircraft in agriculture has a considerable effect on reduction in labor expenditures per unit of output, lowers its prime cost and increases the profitableness of production. So, with an increase in the volume of aerial top-dressings of sowings of winter wheat approximately 4 times under the conditions of Krasnodar Kray labor expenditures per centner of grain are reduced more than 2 times, prime cost descends 1.8 times, and the level of profitableness of its production increases 41%.

Simultaneously with airborne chemical operations in agriculture work constantly proceeds on the use of aircraft in other branches of the national economy also.

Aircraft found wide application in aerial photography. The advantage of aerial photography over surface photography insured its considerable rate of growth. At present these operations are carried out on millions of square kilometers.

From the mid 20's aircraft began to be utilized in northern latitudes for ice reconnaissance and the investigation of polar spaces. Along with ice reconnaissance by aircraft other works were carried out: scientific research, geological, transport, survey and reconnaissance, etc.

According to production use of the Civil Air Fleet in the national economy of the USSR it now solidly occupies the first place in the world. Aviation technology received especially wide application in the development of the economy of Siberia and the Far East. Yearly in these regions on an area of several millions of square kilometers aerial photography, mapping, investigation of new railroad and automobile routes, and study of the water state of rivers for the design of bridges are carried out.

Because of aviation the discovery of the richest Sredne-Angara iron-ore basin, famous Yakut diamonds, and vast oil-bearing layers

in the Tyumensk oblast' became possible. In the Maritime Provinces of Siberia, on the Kola peninsula, in Central Asia, and in the Urals - aviators work fruitfully everywhere now in prospecting for economic minerals, helping the geologists to uncover the underground treasure.

With the aid of aircraft scientists thoroughly study the atmosphere investigating the flow of air masses which makes it possible to find out about the weather and to compose weather maps. Aviation helps weather forecasters to prepare more precise weather forecasts which has great national economic value.

Powerful helicopters are used successfully in the building of high-voltage lines and industrial plants. They transport and install power transmission towers, steel girders, concrete slabs, pipes, and other heavy loads. At the Yaroslavl busbar plant for example, with the aid of an Mi-6 helicopter powerful vulcanizers were installed through apertures in the roof. Utilizing a helicopter, a metallic tank whose diameter is 4 m and whose weight is 5 t was placed on a 20 meter water tower on the outskirts of Moscow. In Ves'yegonske of the Kalinin oblast' and Dmitro-Taranov of the Belgorod oblast' high plant pipes were repaired with the aid of a helicopter. The construction of a high-voltage line on Sakhalin and the Shaim-Tyumensk oil pipeline which passes through strongly swampy terrain in inaccessible taiga areas became possible only because of the use of helicopters.

The rotary-wing giant Mi-10 is able to transport busses, houses and other large loads. This unique helicopter lifts loads weighing up to 12 t. It transports bridge girders, floor beams, and oil derricks through the air and installs them with great accuracy. The use of helicopters in building makes it possible to considerably lower costs in the building of important objects. Data of domestic experience in the building of drilling rigs, power transmission lines, and various constructions show that in

areas with severe climatic conditions the use of helicopter technology provides a reduction in expenditures on these purposes on the average of 20-25%.

Because of wide application of aviation the mastery of the arctic and antarctic areas became possible. Many glorious pages are inscribed by aviation in the study of these areas. The airplanes and helicopters yearly transport polar explorers, thousands of tons of all possible cargo and mail. The turboprop aircraft An-12 maintains regular connection between the mainland, polar stations, and winter quarters. They deliver there foodstuffs, fuel, equipment, and prefabricated houses - everything that is necessary to man for life under severe polar conditions. Fifteen scientific polar drifing stations were organized and are serviced only with the aid of aviation. The airmen of polar aviation carry out reconnaissance for the shortest paths for the piloting of vessels between ice fields, they service polar weather stations, and accomplish in truth heroic, unprecedented flights under severe conditions. Pilot A. Pimenov's nonstop flight through the sixth continent from Lazarevskaya to the main Soviet base in Antarctica, Mirnyy settlement, can serve as an example. Without the work of aviation life in the Arctic and Antarctic would be unthinkable.

The development of Soviet aviation science and engineering made it possible to use aircraft extensively in fisheries. The aviators are now engaged in reconnaissance for fish and marine beasts (walruses, whales, seals). In season airplanes and helicopters faultlessly indicate to the fleet the trawling routes and guide it to the target not only in coastal waters, but also in distant oceanic expanses. On the flag ships of whale flotillas specially equipped helicopters are constantly based which indicate to the whalers the gathering place of marine animals.

Aviation is utilized for scouting the ice situation, for the transportation of cargo and mail to fishermen, and for the rendering of aid to vessels in distress.

Use of aviation in fisheries contributes to the reproduction of reserves and increases the yield of fish and marine animals with considerable savings in expenditure of labor and monetary resources.

Aviation is used in game management: for counting moose in forests, scouting wild deer on the tundra, inventory of waterfowl on the sea coasts, and delivery of teams of hunters to the taiga and taking out their game.

In no other country of the world does medical aviation play such an important role in the system of public health as in the USSR. Civil aviation enterprises now service approximately 200 medical aviation stations of the Ministry of Public Health. Medical aviation in the Soviet Union occupies a visible place in the general complex of measures directed at the further approach of qualified medical aid to the population of peripheral areas and an improvement in the quality of this aid.

Great successes has also been achieved in recent years in the field of application of aviation in forestry.

The enormous extent of forests from west to east and from north to south, and also the disposition of forests in mountainous, floodplain, swampy and other sharply different conditions create great difficulties in operations in forest areas. And here aviation comes to aid. With the aid of aviation the detection of fires and the delivery of parachutists, aerial fire brigades, means of extinguishing, and necessary loads to places of forest fires are conducted.

At present in the general complex of aviation maintenance of forestry special forest pathology inspections for the purpose of determination of origins of the mass multiplication of harmful insects and determination of the health state of forests occupy a significant position. Such inspections are especially valuable in sparsely populated and almost inaccessible areas where ground-based forest conservation cannot detect the appearing sources of pests in time.

With the aid of airplanes and helicopters such works as the account of timber reserves, phonological observations, account of the fruitbearing of plantings, aviation chemical control of pests, inspection of timber-cutting assets, negative, color and spectrozonal aerial photography of forests, aerial sowing of tree crop seeds, and other works are now carried out.

The Communist Party and the Soviet government have always given much attention to the development of civil aviation and to its use in the national economy. In the report "On the fiftieth anniversary of the Union of Soviet Socialist Republics" comrade L. I. Brezhnev said: "the main problem now is to abruptly change orientation, to shift to intense methods of management of the economy, to insure thereby a serious increase in economic effectiveness. The question is for economic growth to a greater degree to take a course of increase in labor productivity and acceleration of scientific-technical progress by the fuller use of the effective productive capacity and by an increase of output from every rouble invested in the economy, every ton of utilized metal, fuel, cement, and fertilizer".

In light of the solution of problems of increase in the effectiveness of public production, increase in labor productivity, and reduction in expenditures during the production of a unit of output; the goal of reduction in the prime cost of aviation

operations by the perfection of aviation technology, equipment and technology of execution of aviation operations, and increase in aircraft performance stands before civil aviation.

Creation of new and modernization of existing aviation technology and special equipment for the fulfillment of the needs and demands of the different branches of the national economy and the use of new materials, substances, and preparations with increased qualitative characteristics will make it possible to raise and to expand the use of aviation technology in the national economy and will contribute to the successful realization of the decisions of the XXIV Congress of the CPSU.

INTERNATIONAL CONNECTIONS OF AEROFLOT

Half a century ago the world press wrote about the first routes of the Soviet aviators, Moscow - Lower Novgorod and Moscow - Koenigsberg, as sensational events. Today the aircraft of Aeroflot take off into the sky to deliver passengers from the USSR to capitals and large cities of more than 60 countries of Europe, Asia, Africa and America. The total extent of the international routes of Aeroflot comprised in 1970 225 thous. km (figure 5).

The first international line, Moscow - Kovno - Koenigsberg, was opened on 1 May 1922 on the basis of a concession presented by the Soviet government to the German air communications company "Deruluft". Beginning in 1927 international collaboration of the USSR began to be realized by means of the conclusion of intergovernmental agreements.

In the course of a decade agreements were concluded with the governments Germany and Iran (1927), Afghanistan (1928), Czechoslovakia (1935), Mongolian People's Republic (1936), and

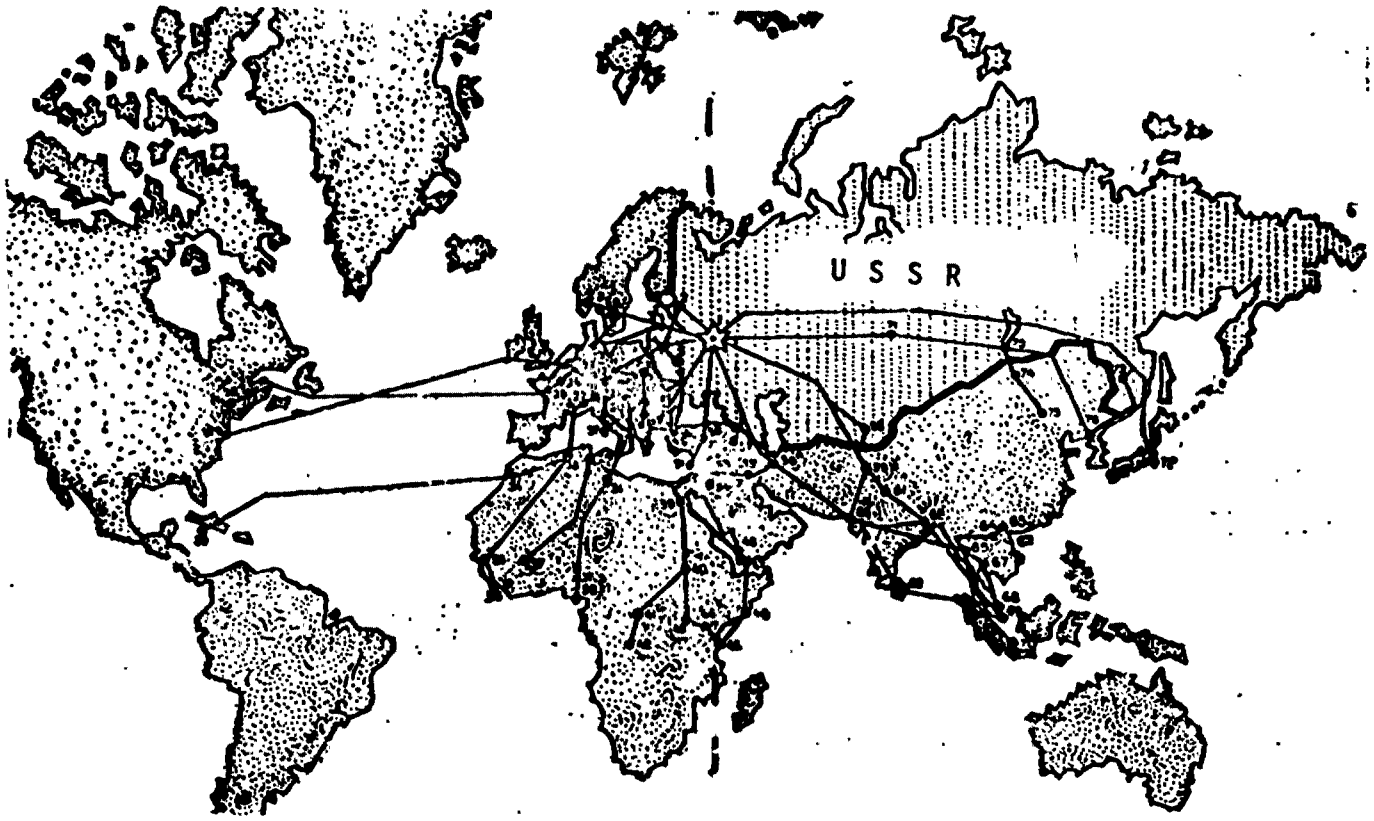

Figure 5. International lines of Aeroflot: 1 - Moscow; 2 - Leningrad; 3 - Riga; 4 - Vilnyus; 5 - Minsk; 6 - Kiev; 7 - Helsinki; 8 - Stockholm; 9 - Oslo; 10 - Copenhagen; 11 - Berlin; 12 - Dresden; 13 - Prague; 14 - Bratislava; 15 - Warsaw; 16 - Bucharest; 17 - Sofia; 18 - Belgrade; 19 - Budapest; 20 - Vienna; 21 - Zurich; 22 - Geneva; 23 - Amsterdam; 24 - Brussels; 25 - London; 26 - Paris; 27 - Rome; 28 - Montreal; 29 - New York; 30 - Havana; 31 - Tripoli; 32 - Tunis; 33 - Algiers; 34 - Rabat; 35 - Dakar; 36 - Conakry; 37 - Bamako; 38 - Lagos; 39 - Cairo; 40 - Khartoum; 41 - Bangui; 42 - Brazzaville; 43 - Entebbe; 44 - Nairobi; 45 - Dar es Salaam; 46 - Mogadisho; 47 - Aden; 48 - Al Hudaydah; 49 - Istanbul; 50 - Ankara; 51 - Nicosia; 52 - Beirut; 53 - Damascus; 54 - Amman; 55 - Baghdad; 56 - Teheran; 57 - Yerevan; 58 - Tashkent; 59 - Kabul; 60 - Karachi; 61 - Delhi; 62 - Colombo; 63 - Calcutta; 64 - Vientiane; 65 - Hanoi; 66 - Rangoon; 67 - Bangkok; 68 - Kuala Lumpur; 69 - Singapore; 70 - Djakarta; 71 - Omsk; 72 - Irkutsk; 73 - Khabarovsk; 74 - Ulan Bator; 75 - Peking; 76 - Pyongyang; 77 - Tokyo.

Bulgaria (1939). The Main Administration of the Civil Air Fleet represented the Soviet Union in these agreements. A series of agreements was concluded with the departments of civil aviation of some states also. Thus, in 1937 on the basis of an interdepartmental agreement air communication was established with Sweden and agreement was obtained from the department of civil aviation of Latvia for the operation of an air line Moscow - Stockholm via Riga; and in 1939 - with China, by the creation of the Soviet-Chinese society of civil aviation Hami - Ata for the operation of a line between the cities of Hami and Alma-Ata.

By agreement with Afghanistan, Czechoslovakia, Germany and Swedish air transport enterprise, air communications had to be carried on by aircraft enterprises of both sides. The agreement with Afghanistan, for example, for communication on the line Kabul - Tashkent provided for two scheduled flights per month with the use of two aircraft of each side. Actually, flights were made only by the Soviet side.

It is characteristic that already at that time the Soviet Union rendered gratuitous aid on air route and airfield equipment to those countries where there was no such equipment.

Since 1937 an enterprise formed specially for these purposes - the Administration of International Airlines of the USSR (UMVL) [УМВЛ] has been in charge of questions of the operation of Soviet international lines.

Until 1954 air communications between the USSR and other countries were realized predominantly by Aeroflot. Air communications connected our country with Bulgaria, Yugoslavia, Albania, Hungary, Austria, Czechoslovakia, Poland, Iran, Finland, Afganistan, China, and the People's Democratic Republic of Korea (PDRK). Communications with a number of countries were effected

via Finland, where passengers were transferred to aircraft of the Swedish airline.

In 1954 by agreement with France a Franco-Soviet air line Moscow - Prague - Paris was organized. Beginning in 1955, the USSR concluded a series of agreements for bilateral flights. Aircraft of Czechoslovakia and Poland began to make flights to the Soviet Union first. Of the airlines of the capitalist countries in 1956 the Finnish airline "Aero" first began flights to Moscow.

Since 1971 the Central Administration of International Air Communications (TsU MVS) [ЦУ МВС] began to carry on international air communications representing Aeroflot in the international arena.

Now the international connections of Aeroflot are very vast. An important place in the international collaboration of Soviet civil aviation is assigned to collaboration with the socialist member countries of the Council for Mutual Economic Assistance (COMECON) [СЭВ]. Civil aviation of member countries of COMECON is continuously supplemented by high-speed and highly productive aircraft, the volume of air transportations constantly grows.

From 1960 to 1970 the total volume of the air transportations executed by the air transport enterprises of member countries of COMECON increased 5.5 times, while international transportations increased more than 6.6 times. In this case the specific weight of the total air transportations of countries of the socialist collaboration in world volume increased from 12.1 to 16.3%, and the volume of passenger air transportations increased from 13.6 to 18.9% and composes at present almost a fifth of the world's passenger transportations.

To 1970 the quantity of all routine international air lines of the member countries of COMECON increased more than 2 times in comparison with 1960.

By the joint efforts of the member countries of COMECON many of civil aviation's most important problems of scientific-technical research are solved and methods of organization of international transportation are improved. Considerable attention is given to questions of the technical operation of the aircraft fleet and to standard methods of maintenance and repair of aviation equipment.

In the area of uses of civil aviation in the national economy the questions of the general development trend of special use aviation and the technical requirements for aircraft intended for work in agriculture are examined, the areas of application of helicopters in the different spheres of the national economy are determined, etc.

Technical requirements are developed on equipment for flaw detection during the operation of aircraft and helicopters. Standard methods of collection and machine processing of statistical data on failures and malfunctions of aviation equipment are created by specialists of the USSR, GDR and CSR.

According to the plans for scientific-technical collaboration specialists of the member countries of COMECON proposed a whole series of technical and economical requirements for airports, airplanes, helicopters, and modern equipment used on international lines being constructed and reconstructed.

One of the actual subjects which specialists of the PRB, HPR, GDR, PPR, USSR, and CSR are investigating is connected with the forthcoming operation and maintenance of high capacity aircraft

and supersonic aircraft on the airlines. These investigations foresee the conducting of a complex of works on preparation for the operation of aircraft of such type for the purpose of an increase in the effectiveness of their use.

Another less important subject is the mechanization of loading-unloading operations on air transport with the use of pallets and containers, which will make it possible to reduce time and to lower the prime cost of loading-unloading operations during transportation by air transport of commercial loads, mail and passengers luggage. Specialists of the USSR, GDR and CSR are working this problem out.

After joining the Chicago convention (1914) on 14 November 1970 the Soviet Union became a member of the International Civil Aviation Organization (ICAO) - a specialized institution of the United Nations (U.N.). The important international value of this fact lies in the fact that the Soviet Union again confirmed that acknowledgement of the principle of state sovereignty is the most important premise of the peaceful coexistence of states with different sociopolitical systems, and therefore the participation of the USSR in this international treaty which legally secures the acknowledgement of this important principle considerably increases the authority and significance of this treaty.

To provide for the active participation of the Soviet Union in the activity of the ICAO a series of measures were taken in our country. First of all the USSR Commission for ICAO Matters was created members of which are the key staff members of the Ministry of Civil Aviation and other interested ministries and departments. The Chairman of the Commission is the Minister of Civil Aviation. The Commission is called periodically several times per year and examines the most important questions which concern the participation of the USSR in ICAO.

For working out large problems five working committees attached to the USSR Commission for ICAO Matters function covering all sides of ICAO activity: the Air Navigation Committee, the Airworthiness Standards Committee, the Air Transport Committee, the Technical Committee, and the Administrative-Legal Committee. Committees, in turn, consist of groups of experts.

CONTEMPORARY AIRPLANES AND HELICOPTERS

When we speak about contemporary airplanes and helicopters as a rule we have in mind those that at present are utilized on the lines of civil aviation. On a wider plane it is also possible to speak about those airplanes and helicopters which will appear in operation in the near future.

Airplane and helicopter "life" in civil aviation is sufficiently prolonged. The history of aviation knows such "long-livers" as aircraft PO-2, which we discussed earlier, or aircraft An-2.

These "long-livers" are utilized in aviation 25-30 years. The average lifetime of aircraft is usually 15-20 years. Thus, when speaking about contemporary airplanes and helicopters we speak about those that were created 10-15 years ago also.

Before writing the individual types of airplanes and helicopters it is necessary to say that the development of civil aviation and its formation as a branch of the national economy of the country led to the need for the creation of the definite classification of all aircraft according to their purpose and field of application. This classification was created by civil aviation specialists on the basis of operating experience, analysis of air transportation, and predictions of aeronautical development.

All aircraft and helicopters are divided into: passenger, cargo, special purpose (agricultural, medical, aerial survey, etc.), and training.

During the creation of an aircraft or a helicopter the sphere of its application is determined: will it be, for example, only a passenger aircraft or only cargo, or an aircraft that can be converted from passenger to cargo.

In the first years of the development of civil aviation when the volumes of operations were relatively low there was no particular need for the creation of specialized aircraft. At present the diversity and volumes of operations has increased so, that it is both technically and economically profitable to create specialized aircraft. True, in this case, the possibility of the fulfillment of different functions by one and the same aircraft is always examined. Today such a "non-specialist" is aircraft An-2: it is utilized as passenger, cargo, agricultural, etc.

At the proper time this was well. Now requirements for aircraft of different purposes has so increased that to obtain wide universality in one aircraft type is very difficult; therefore the An-2, from this viewpoint, is already obsolete as a passenger, and as a cargo, and as an agricultural aircraft. As a result the creation of new specialized aircraft was required.

In turn, passenger aircraft are divided according to their area of application into long, medium, and short-range trunkline aircraft and heavy and light aircraft of the local lines.

Long-range trunkline aircraft include the Tu-114, the Il-62, and Il-62M. The aircraft Tu-114 is widely-known not only to Soviet, but also to many foreign air passengers. The first Soviet long-range passenger aircraft Tu-114 appeared on the lines of

civil aviation in the mid 50's and we proudly followed its flights to Havana, New York and many other cities of the world. Now the Tu-114 operates on domestic lines of Aeroflot: Moscow - Khabarovsk, Moscow - Tashkent, etc.

The long-range trunk line turbojet Il-62 and Il-62M were created to replace the Tu-114. These aircraft fly to many countries of the world and within the country.

Long-range trunk line passenger aircraft are presented with exceptionally high requirements not only with respect to reliability and efficiency, but also with respect to provision for passenger comfort. Even at a speed of 900-950 km/h a flight from Moscow to Khabarovsk occupies 8 hours, to Tokyo - 10, and to New York - 11.5 hours. Being such a time in the airplane passenger compartment, the passenger should not tire. For this reason airconditioning systems, soundproofing, comfortable seats, aesthetical finishing of passenger compartments, musical and television programs are created, food is served, etc.

In the near future the supersonic Tu-144 (figure 6) created by the design collective under the guidance of academician A. N. Tupolev will appear in the class of long-range trunkline aircraft. To fly on such an aircraft will be a pleasure. Reliability of construction, convenience and comfort for the passengers, and half the time of flight. The Tu-144 is the crown of aviation design thought of the great creative work of workers and testers.

Civil aviation will be the first aviation company to use supersonic aircraft.

The Tu-104, Il-18 and Tu-154 are medium-range trunkline aircraft. They operate on such lines as Moscow - Sochi, Moscow - Simferopol', Moscow - Omsk, Novosibirsk - Sverdlovsk, etc. The

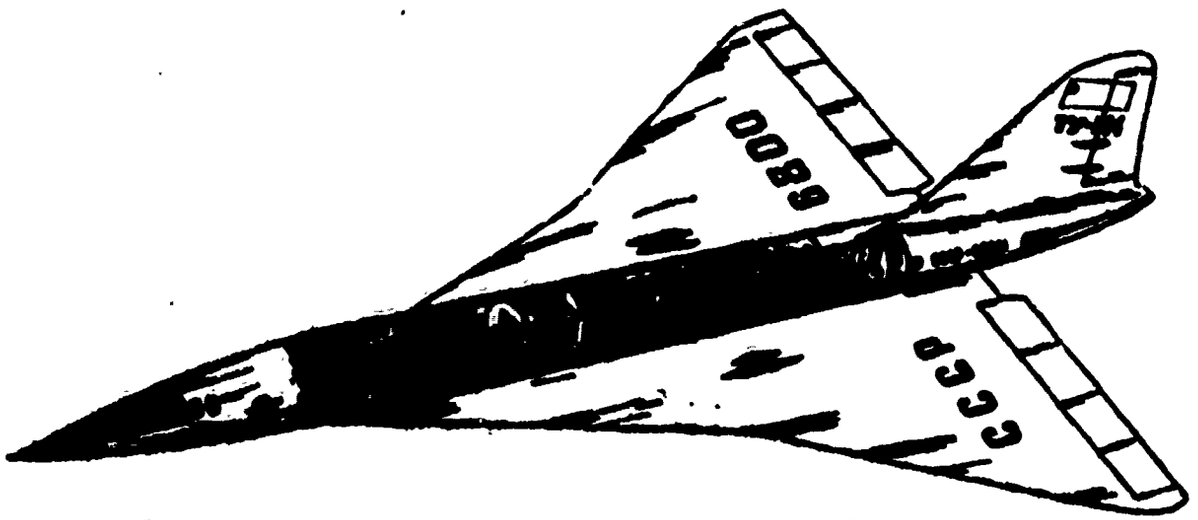

Figure 6. Supersonic passenger aircraft Tu-144.

Tu-104 was the first in our domestic jet passenger aviation. The renowned collective of academician A. N. Tupolev, to whom was awarded the large gold medal during the International Exhibition created this aircraft.

The aircraft Il-18 is also widely known to Soviet and foreign air passengers as is the name of its creator - S. V. Ilyushin.

Aircraft Tu-104 and Il-18 have been and are of good service to civil aviation. Millions of hours have been flown on them, many hundreds of thousands of passengers and thousands of tons of mail and cargo have been transported. But life goes on, and people present higher requirements for aircraft. As a replacement for the Tu-104 and Il-18 on the lines of civil aviation on 9 February 1972 the Tu-154 appeared - a second generation jet passenger aircraft. Of more ideal construction, more economical, more comfortable for the passengers, better equipped with modern air navigation equipment; these are the basic features of this aircraft. In the class of medium-range trunkline aircraft is created the new Il-86 - the first domestic air bus with 350 seats.

The Tu-124 and Tu-134 are short-range trunkline aircraft. They are utilized on lines up to 1500-2000 km in extent, where

passenger flows are less than on the medium-range lines. A new short-range trunkline aircraft is now being created which will replace the Tu-124 and Tu-134.

The An-24 and Yak-40 are heavy aircraft of the local lines. These aircraft are utilized on comparatively short lines with low passenger flows.

Aircraft An-24 designed by O. K. Antonov was created in 1959 and now operates widely on the lines of civil aviation.

The aircraft Yak-40 designed by A. S. Yakovlev achieves ever greater popularity with the air passengers and is becoming the mass machine on the local lines. The aircraft possesses great reliability, good comfort for the passengers, and simplicity in operation.

The An-2 is a light aircraft of the local lines. The aircraft is very popular in our country. Created by the collective of O. K. Antonov in 1947, it is still widely utilized in civil aviation. The aircraft L-410 built by the aviation specialists of our brother socialists Czechoslovakia will enter operation in 1973 to replace the An-2 aircraft on the local lines. This is a twin-engined turboprop aircraft with high comfort for the passengers.

The An-12 belongs to the cargo aircraft which are operated in civil aviation. It transports diverse loads for the national economy, vegetables and fruits from the southern areas of the country to the northern. The development of cargo air transportation forces the creation of new, more ideal aircraft. The aircraft Il-76 and An-26 will appear in the near future in civil aviation. They will make it possible to considerably expand the sphere of application of aviation for freight handling.

Table 5

Aircraft type	Cruising speed, km/h	Number of passenger seats	Range, km	Maximum takeoff weight, t
Tu-114	770	200	8000	173.5
Il-62	900	186	8600	161.5
Il-62 M	900	198	10,500	165
Tu-144	2350	126	6500	130
Tu-104	800	100-115	2900	78
Il-18	600	100	3500	61.2
Tu-154	940	154	4200	90
Il-86	950	350	4600	176
Tu-124	800	56	2000	38
Tu-134	900	80	3000	47
An-24	450	52	2500	21.8
Yak-40	510	27-32	1480	16.1
An-2	215	12	835	5.2
L-410	380	15-17	1000	5.4

Table 6

Aircraft type	Cruising speed, km/h	Maximum payload, t	Range, km	Maximum takeoff weight, t
An-12	600	14.5	5000	54
An-26	450	5.5	2650	24
Il-76	900	40	5700	160

Existing aircraft types An-2, An-24, Il-18, etc are re-equipped at present for special purpose use. Aircraft An-2 in the agricultural version is the most widespread. The volumes of agricultural operations in recent years has so increased that a special agricultural aircraft more productive and more economical than the An-2 was required. The aircraft designers of the Polish People's Republic undertook this task with the assistance and

active aid of the Soviet aircraft designers. This aircraft (they named it M-15 in honor of the city of Melets in Poland, where it was designed and will be constructed) will appear in the near future above the fields of our country.

The training aircraft Yak-18T created by A. S. Yakovlev is utilized for initial pilot training of civil aviation. Subsequent pilot training is conducted in those types of airplanes and helicopters (table 7) for which they (the pilots) are preparing.

Table 7

Aircraft type	Operational speed, km/h	Weight of chemicals, kg	Width of coverage, m	Takeoff weight, kg
An-2	160	1400	22	5250
M-15	160	2200	50	5400
Yak-18 T	265	240	-	1620

Helicopters are widely utilized in the national economy of the country. Civil aviation has helicopters Mi-2, Mi-10, Mi-6, Mi-8, Mi-4, and Mi-1 designed by Mil, and Ka-26, Ka-15, and Ka-18 designed by N. I. Kamov. It is difficult to enumerate all the types of operations which helicopters carry out today. They are utilized in construction, service to geologists, for hunting, rendering of aid to people in distress, agricultural works, etc.

In accordance with the work being carried out one type or other of helicopter is appropriately equipped. Helicopters Mi-1, Mi-2, Ka-15, Ka-18, and Ka-26 are most widely utilized in agriculture, helicopters Mi-4 and Mi-8 for passenger transportations and the maintenance of geological survey parties, helicopters Mi-6 and Mi-10 for construction and erection works and the transportation of outsized loads (table 8).

Figures 7-9 give three characteristics of our aircraft: range, flying speed, and passenger capacity.

Table 8

Type of helicopter	Cruising speed, km/h	Number of passengers or payload	Range, km
Mi-2	180	6-8	600
Mi-10	180	12	500
Mi-6	250	12	620
Mi-8	225	4	425
Mi-1	170	3	255
Mi-4	140	12-16	475
Ka-26	150	7 (900 kg)	400
Ka-15	130	1 (220 kg)	260
Ka-18	130	3 (255 kg)	260

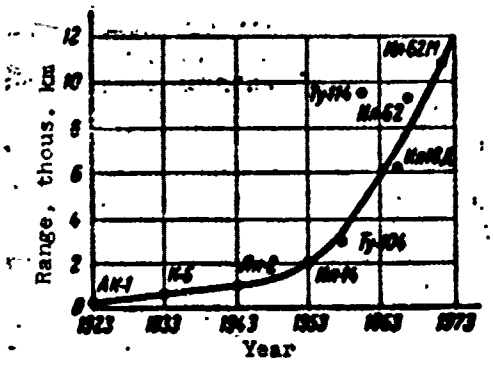

Figure 7. Range of passenger aircraft.

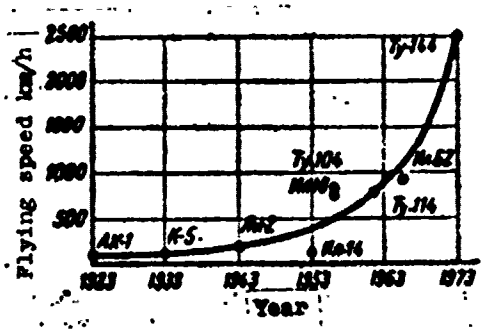

Figure 8. Dynamics of increase in the speed of series passenger aircraft.

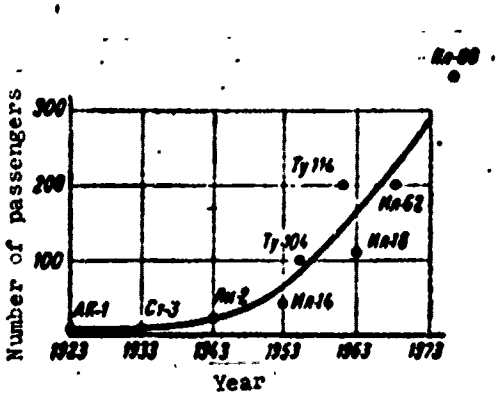

Figure 9. Dynamics of increase in passenger capacity of series passenger aircraft.

Aeronautical development in 50 years is connected with the creativity of our aircraft designers; A. N. Tupolev, S. V. Ilyushin, A. S. Yakovlev, O. K. Antonov, and the younger generation of aircraft designers; A. A. Tupolev, G. V. Novozhilov, M. A. Tishchenko, R. Izmailov, and their collectives. In this development great merit is also due the workers of civil aviation - the pilots, engineers, scientists, testers, all those who operate equipment, who expose its deficiencies, evaluate technology, and place new requirements with respect to its development and perfection. History knows many examples when, because of the work and heroism of people, dangerous unknown phenomena were exposed and removed.

AIR NAVIGATION AND AIR TRAFFIC CONTROL FACILITIES

The flight of modern civil aviation aircraft from one point to another may be divided into three stages: takeoff, flight enroute, and landing. In this case the flight should be accomplished strictly according to schedule by day and night and in virtually any weather. Technical equipment which makes it possible to accurately hold direction, speed, and flight altitude and to know the position of the aircraft relative to the earth must be available to the aircrew. The creation of such technical equipment proved to be a problem not less complex than the creation of aircraft. Only development of such sciences as physics, radio engineering, radar, electrical engineering, etc. allowed the scientists, designers, and engineers to create modern air navigation equipment.

But how did the first civil aviation aircraft fly? Visually, i.e. so that the pilot always saw the earth and was oriented by the most noticeable objects (rivers, railroads, populated points). In the pilot's cabin were the simplest instruments: altimeter, speed indicator, magnetic compass. The accuracy of the instruments was very low; therefore the pilot relied more on his own observations of the ground. While he saw the ground he could fly, if

the ground was covered by fog, clouds or dusk fell, flight ceased.

But what is to be done if in flight wind blows on the side? It carries the aircraft away, and this must be considered. In the 20's navigator V. G. Nemchinov developed the navigational computer making it possible to determine and allow for the cross wind to determine ground speed more precisely. Now automatic devices are utilized for this purpose which make it possible to continuously allow for wind velocity and direction.

The appearance in the thirties of gyroscopic instruments on civil aviation aircraft was a very great event, since they made it possible for the pilot to determine the position of the aircraft relative to the horizon without ground visibility. This virtually opened the way to flights in clouds, in fog, and at night. In 1936-1938 autopilots were developed and placed on some aircraft types. These are devices making it possible during certain phases of flight to pilot the airplane without the pilot's interference. In comparison with existing autopilots these were, of course, the simplest devices.

The development of civil aviation as a transport branch of the national economy required a solution to the questions of flight regularity. It was necessary to find such technical solutions which would make it possible to fly at night and in comparatively adverse weather conditions. For this were created not only airborne air navigation equipment but also ground-based technical equipment helping the pilot to rapidly and correctly fix the position of the aircraft.

In 1934 on the air line Moscow - Sverdlovsk at the Moscow, Arzamas, Kazan' and Sverdlovsk airports radio beacons and radio marker beacons were built. The very name of this equipment indicates that they helped the pilot to control his flight in

direction and in time of passover of control points (radio marker beacons).

In subsequent years (1935-1937) similar radio beacons were installed at all airports from Moscow to Vladivostok.

The installation of radio beacons on the route Ordzhonikidze - Tbilisi insured the flights of postal aircraft through the Caucasus Mountains.

The first radiotelephone communication under scheduled flight conditions was realized in 1935 during flight on the route Novosibirsk - Kemerovo on a K-5 aircraft. This was a great victory for Soviet scientists, designers, and engineers on the way to perfection of civil aviation technology.

The explosive development of radio engineering and radar in pre-war and especially postwar years made it possible to create new effective air navigation equipment. In 1938-1939 the first ground-based radio direction finders were created which made it possible to determine the location of aircraft rapidly and with sufficient accuracy. The first experimental batch of ground-based radio direction finders was installed on the route Moscow - Tashkent. In the first years of the Great Patriotic War a powerful direction-finding center was created on the outskirts of Moscow which played a large role in safeguarding the flight of Aeroflot aircraft in the enemy's deep rear. In 1945-1955 on the basis of radio engineering and radar means airborne and ground-based complexes of equipment were created which make it possible for an aircraft to make flights on the air routes with great accuracy and to land in more adverse weather conditions. The SP-50 landing approach systems which include homing stations, markers and airborne radio compasses were created specially for the technical security of landing.

The jet aircraft which appeared in the 50's radically changed the requirements for air navigation equipment and methods. This was connected first of all with an increase in speed and flying range. The greater the speed, the less time the pilot has for solving one problem or another. The greater the distance of nonstop flight, the more perceptible an error in navigational calculation. Under such complex conditions a man could not cope with the many air navigation operations. It was necessary to automate the basic processes for carrying out air navigation at great flying speeds and to create equipment possessing considerably higher accuracy. In 1950-1960 a series of new models of navigational equipment was created - heading systems with magnetic, gyroscopic and astronomical sensors, ground speed and drift angle meters, navigational calculators, new radio compasses with automated adjustment, airborne navigational radars, etc.

With the advent of high-speed jet aircraft in civil aviation the creation of special flight regulations on air routes and descent and landing approach regulations was required.

Technical equipment and the organizational measures carried out in civil aviation made it possible to rapidly master jet technology and to insure its routine and safe operation.

The last decade (1963-1973) of the development of navigation aids and air navigation is characterized, mainly, by the further automation of the basic processes and by an increase in accuracy and reliability.

It should be mentioned that the development of navigation aids and air navigation also led to the fact that a very large number of instruments, panels, cranks, etc. appeared in the cockpit. It was necessary for pilots to analyze the readings of many instruments in a very short time (fractions of a second). Therefore, naturally, searches for ways for easing the pilots' work

and standarization of equipment were initiated. Recently in civil aviation basic navigational complexes according to classes of aircraft were worked out and introduced. The basic complex makes it possible for a given class of aircraft to standardize equipment both as to composition and its arrangement in the cabin, which considerably facilitates training of pilots and their work.

All stages of aircraft flight (takeoff, flight enroute, and landing) are important for the crew, but perhaps the most complex is the landing approach and the landing. That is why this stage of flight is always given special attention during the development of technical air navigation equipment.

During landing approach the pilot must accurately hold the line of descent (glide path) and heading (course) by means of corresponding actions of the aircraft control surfaces and engine thrust. If the flight is at slow speed and under conditions of good visibility, then the pilot does not experience special difficulties. But if the speed is great and flight is made in clouds, in fog, or at night, then landing approach without special equipment is virtually impossible.

We already mentioned the fact that in the 50's the SP-50 landing system was created making it possible for the pilot to follow the glide path and course of descent in more adverse weather conditions. However, it was necessary to follow a large number of instruments and to simultaneously control the aircraft. In jet aircraft this was a difficult task. Subsequent to the perfection of the SP-50 landing system the "Put'" and "Privod" type director systems were created. Visualization of the operation of these systems may be simplified thus. All information from ground-based equipment - radio beacons and radio marker beacons (glide and course) - is processed by airborne equipment and is transmitted to one instrument - the director - in a convenient form for reading. For determining the position of aircraft according to

course and line of descent (on the glide path) the pilot uses the "main" and convenient instrument - the director. In this case the system is called the director system of landing approach. Implementation of director systems considerably eased the work of the pilots and increased the accuracy of the landing approach. At the same time the systems made it possible to perform jet aircraft landings in more adverse weather conditions.

The next development stage of landing systems was the creation of automatic landing approach systems. Speaking simply, if information from the director instrument is transmitted to the autopilot which in this case will hold the aircraft on the glide path and on course, then the pilot's work will be eased even more and he can give more attention to checking the traffic conditions and to observation of the surrounding situation. In this case the accuracy of landing approach proves to be greater.

In the 60's a domestic automatic landing approach system which successfully operates in civil aviation was created.

Subsequent works on the improvement of navigation aids and air navigation made it possible to create automatic landing approach systems making it possible to make flights under conditions of very poor weather. At present these systems are being introduced in civil aviation. In order to clearly visualize the effect of automatic landing systems on the regularity of flights let us give these examples. In the absence of landing aids the pilot could make a landing only in the daytime under conditions of clear sunny weather. With the implementation of the SP-50 landing system landing became possible day and night, if cloud height was not below 800 m, and horizontal visibility was not less than 2000 m. The automated director landing system makes it possible to land day and night with cloud height not below 200 m and horizontal visibility not less than 1200 m. Category I automatic systems make it possible to land with a cloud height of

60 m and visibility 800 m, Category II - with a cloud height of 30 m and visibility 400 m, Category III - at a cloud height of 15 m and visibility 200 m.

In flight terminology these are expressed as landing minimum Categories I, II and III. The landing minimum determines for a pilot the minimum possible values of cloud height and horizontal visibility which allow him to land with the equipment available aboard the aircraft and at the airport of landing. If it is said that the pilot can land in a given aircraft type at a given airport at a landing minimum of Category I, then this means that the aircraft airborne equipment, airport equipment, and pilot's training make it possible to land at a cloud height of not less than 60 m and visibility not less than 800 m.

Implementation of equipment for Category I landing systems in civil aviation considerably raised the regularity and safety of flight. Implementation of Category II and III equipment will make flights of aircraft virtually independent of weather conditions.

Development of air transport leads to an increase in the number of airplanes and helicopters which are in the air simultaneously. If, for example, in the 20's two or three dozen aircraft were in the air simultaneously, then at present thousands of airplanes and helicopters are in the air simultaneously. Thus, at a particular stage of aviation development the problem of the air traffic control became urgent. Figuratively speaking, even air space became tight and strict traffic procedure is necessary there. For this purpose special technical equipment and first of all communications and radar equipment were created.

The first transceivers which worked on medium waves were installed on civil aviation aircraft in the 20's. In the mid 30's radio stations working on short waves began to be installed

on aircraft, and by the mid 50's civil aviation had at its disposal a developed network of radio communication ensuring flight control above the entire territory of the country.

At present civil aviation has available modern and reliable communications equipment for air traffic control and reliable communication between airports. Semi-automatic and automatic communications equipment is being introduced and scientific-technical bases for the use of artificial earth satellites for distant and hyperdistant communication with aircraft are being developed.

At the end of the 40's and beginning of the 50's radar equipment began to be used for control and direction of aircraft traffic. This event can be called a technical revolution in the field of air traffic control. Earlier the position of aircraft in space was determined as a result of calculations according to radio direction finder data which was a comparatively laborious operation barely suitable in practice for checking the relative position of two or more aircraft in the air. With the advent of radar the controller could "see" aircraft on the screen of his instrument, and consequently could "see" the relative position of several aircraft. This in conjunction with direct radio communication "controller - aircraft" became an effective method of air traffic control.

At present civil aviation has several types of radar stations - for air traffic control in the zone of airfield, for air traffic control enroute, etc. The different radar stations have different characteristics as to range of detection and control of aircraft and resolving ability (accuracy). Radar stations are created for the control of long-range trunkline aircraft, short-range trunkline aircraft, and aircraft of the local lines.

At present work is proceeding intensely on the implementation of automated air traffic control systems in which many operations

of collection and processing of information from several aircraft which are in the air simultaneously will be solved with the aid of electronic computers.

CIVIL AVIATION AIRPORTS

Even from the first days of aviation development the need for its ground-based maintenance arose. Beginning in 1908 in Moscow, Petersburg, Kiev, Odessa, Nizhniy Novgorod, and other cities voluntary aeronautical groups appeared whose resources consisted of voluntary donations. Race tracks were utilized as takeoff and landing sites.

The further development of aviation required the creation near these sites of a series of buildings for storage, maintenance, and repair of aircraft. The need arose for the diversion and equipment of special land areas - airfields.

In 1909 one of the voluntary groups the "Kiev Society of Aeronauts" began the construction of the first airfield in Russia on the outskirts of the city of Kiev.

The journal "Herald of Aeronautics" for 1911, for instance, described the airfield of the future thus:

".... a large parade ground, even, free, and enclosed. On the one hand huddles a row of hangers seething with work on assembly, alteration and, probably, repair of missiles; here a shop equipped with machine tools and necessary instruments. There the inventors and designers create new missiles. Here the pilots school, with a drivers school connected to it.

Somewhat further the meteorological station and aerodynamic laboratory building, next to it the kite station and the fleet of sounding balloons. Around the entire parade ground are arranged stands for the public".

At the beginning of the First World War approximately 25 permanent airfields were counted in Russia.

Airfields were constructed only of earth without artificial surfaces, which was completely acceptable for small aircraft (figure 10).

Figure 10. Building of the air communications station of "Dobrolet" in Kazan (1923).

The Council of Labor and Defense on 28 October 1923 accepted a resolution about the procedure for the diversion of land areas not less than 25 dessiatines (27 hect.) each for the layout of airfields and landing sites in immediate proximity to cities and other populated points entering the network of airlines.

With the development of civil aviation domestic airport construction developed rapidly and gradually was distinguished as an independent branch of technology.

The need arose for the creation of special design and construction organizations capable of insuring the creation of new and the reconstruction of existing airports. In December of 1932 a central office for research and design of air lines and airports was created, reorganized in October of 1934 to the specialized institute "Aeroproyekt".

In 1938 construction was initiated on the central airport of the country, Vnukovo, which was finished before the war.

The Vnukovo airport became the first of domestic airport construction. To provide for takeoff and landings of heavy aircraft at Vnukovo a runway was constructed with an artificial surface of monolithic concrete slabs for the first time for a civil airport, concrete parking aprons, taxi ways, and concourses were built. An air terminal, a hangar with metallic trusses, and buildings for storage of fuel and lubricant materials were designed and built.

The Vnukovo airport project reflected characteristic tendencies in airport construction marking this period. They amounted to the following.

Rejection of the circular airfield form and change to strip forms. Realization of such airfields became possible because of improvement in the yawing stability characteristics and handling of aircraft. Takeoff and landing became possible at a certain angle to wind direction, i.e., when a certain lateral velocity component of wind is present. This made it possible to establish one or two runways at airports in the directions of prevailing winds.

Creation at the airfields of a system of artificial surfaces (runways, taxiways, parking aprons, and concourses). The need for the creation of artificial airport surfaces was caused by an increase in the flight weights of aircraft and by an increase in loads on the surfaces. The turf surfaces could not insure the safety and regularity of aviation operation.

Building of large major buildings of the air terminal complex for passenger service and large bay hangars and other major buildings for aircraft maintenance (figure 11).

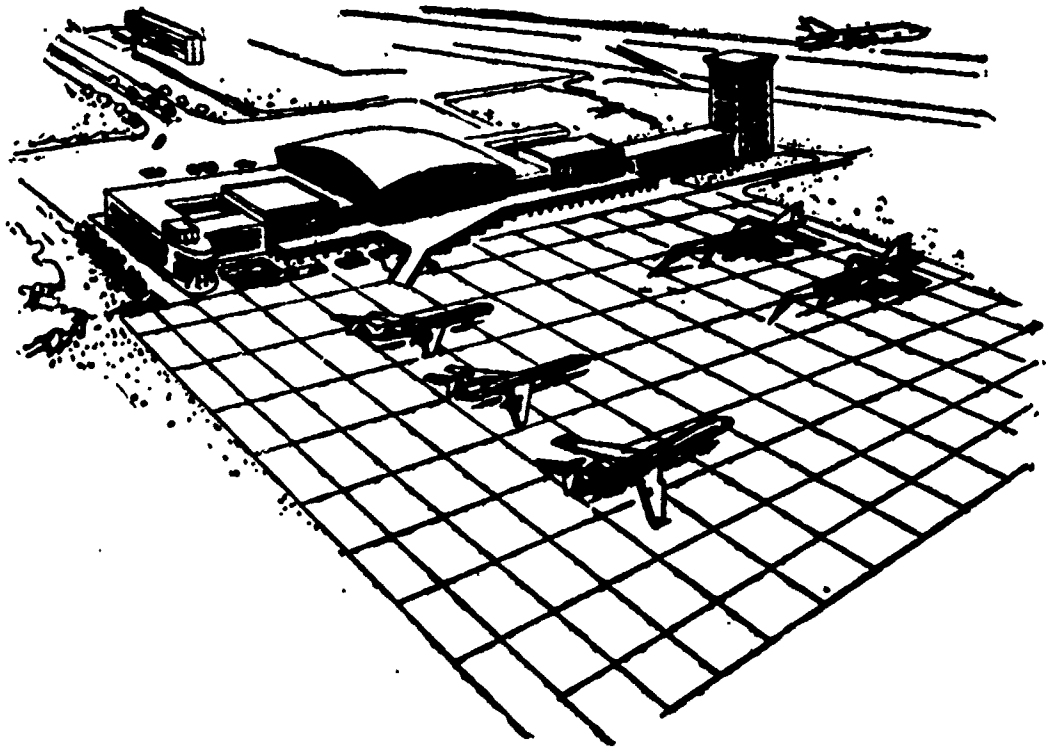

Figure 11. A modern air terminal.

Mass use on Union and international lines of jet and turboprop aircraft put a number of completely new problems before the ground services of Aeroflot.

In 1960-1965 65 airports underwent basic reconstruction and were constructed again (Simferopol', Mineral'nye Vody, Krasnodar, Baku, etc.), the Moscow aviation center was completely reconstructed.

Domodedovo airport was designed by "Aeroproyekt" according to a new layout with two parallel and one perpendicular runway, and with the service-technical territory located between them. An air terminal was built with the ability to pass 3000 passengers per hour, with mechanization of acceptance and delivery of baggage, TV flight schedule display system, comfortable waiting rooms, restaurant, and bar.

Simultaneously major works on the expansion of Vnukovo-1 airport were carried out. Sheremetyevo airport was completely

re-equipped and converted to the international airport of Moscow.

At present new trends in airport building and equipment have been added. Among them may be included: the creation of great conveniences and comfort in passenger service, the automation and mechanization of baggage and cargo processing, the creation of centralized automated systems of aircraft servicing, and the automation of landing and air traffic control.

In 1965-1970 airports in many cities on the main air trunklines of our country were reconstructed and built. Even greater problems on the further expansion and perfection of the network of airports must be solved in the new five-year plan 1970-1975. In the near future new air terminal complexes will be created which answer modern requirements and trends in the building and equipment of airports.

MAINTENANCE OF AVIATION EQUIPMENT

The observation of the takeoff, flight, or landing of a modern jet liner brings pleasure to every person who loves technology. But whoever watched the flight of the first supersonic Tu-144 was enraptured by the swiftness and ease of motion, by the enormous power and the sharpness of shapes. But we tear ourselves away from contemplation and will observe who and what makes the aircraft able to be prepared for flight daily. The designer created the aircraft, the engineers and the workers constructed it and sent it to us, the workers of civil aviation. In order to fly in an aircraft, it is necessary to constantly see to its soundness and to carry out a large volume of works which prevent the appearance of malfunctions. For these purposes the technical service was created from the very beginning of the conception of aviation.

The technical service is first of all aviation specialists (engineers, technologists, motor mechanics) who know aircraft

equipment and its operating regulations well and have at their disposal technical equipment which helps to determine the state of aircraft units, assemblies, and systems.

In the beginning of civil aviation development when aircraft were of simple construction, maintenance entailed the conducting of simple inspection and lubricating operations, the elimination of discovered malfunctions, and the servicing of aircraft with gasoline and oil. An engineering and technical staff, as a rule, was assigned for one aircraft or a fleet.

In proportion to the complication of the construction of aircraft and their outfitting with special equipment the organizational structure of technical services and their function were changed. A system of preventive maintenance was created based on previously developed documents - regulations which determined the volume and order of operations. Specialization of technical personnel was carried out. Now every technical crew consisted of specialists - mechanics, radio men, and electricians. Special technical equipment was created for conducting aircraft maintenance - devices, instruments, mechanisms, etc.

In 1948 in civil aviation line maintenance and repair shops (LERM) [ЛЭРМ] were created, in the composition of which were organized specialized shops, sections, divisions, and laboratories. This made it possible to further improve maintenance methods, to raise the labor productivity of the technical-engineering staff, and to strengthen the monitoring of the state of aviation technology. In the LERM the aircraft were serviced considerably faster and better, and consequently flight time increased and flight safety was raised.

The engineers who worked in the LERM not only directed aircraft maintenance, but also performed analysis of the aircraft status

depending on their time in operation. This gave valuable material for determining the technical service lives of aircraft, engines, and their equipment.

The equipment of civil aviation with new jet equipment (airplanes Il-62, Tu-134, Yak-40, helicopters Mi-2, Mi-8, Mi-6, etc.), a considerable and sharp increase in the volume of transportations and, consequently, also the volume of maintenance work led to new organizational forms of engineering services.

In 1966-1967 the LERM were reorganized as air technical bases (ATB) [АТБ] with more powerful, technically better equipped subdivisions.

The fundamental feature of air technical bases unlike all previously existing organizational forms of the technical services of civil aviation is the fact that the airplanes and helicopters are assigned to these bases. The ATB has its own fleet of airplanes and helicopters. This considerably raised the responsibility of technical personnel for quality and times of conducting of maintenance.

The modern air technical bases of civil aviation differ little from production enterprises in the structure of their subdivisions. They have shops, laboratory, and sections - producing-dispatching, quality control, chief mechanic, technical divisions, engineering and design office, and a series of auxiliary services.

The ATB's plan the use and maintenance of airplanes and helicopters, process propositions for the improvement of maintenance regulations, develop and introduce different technical diagnostic and monitoring equipment, and carry out work on the analysis of aviation equipment operation.

Along with this the ATB collectives work on the perfection of their organizational structure and new methods of planning

and control with the use of electronic computer technology.

Now let us step back from the dry presentation of the history of the development of the technical services of civil aviation and mentally visualize how the maintenance of modern aircraft is conducted today, and let us talk a little about what it will be tomorrow.

The aircraft landed after a routine voyage. The passengers have not yet vacated the passenger compartment, the baggage is not completely unloaded, but the specialists of the air technical base have started their work. First of all it is necessary to obtain full information about the flight from the crew. The crew not only controls the aircraft, it also vigilantly watches its behavior and the readings of all instruments and by virtue of its experience and knowledge gives most valuable information about the technical status of the aircraft. But this is only the preliminary work. The aircraft enters the ATB further. Depending on how long the aircraft flew, and taking into account the information obtained from the crew, the volume of maintenance operations and the times for conducting these operations are determined. Assignments are distributed to the specialized crews who perform these operations. Maintenance includes both simple operations (the visual inspection of assemblies, parts, units, and systems) and very complex which are made with the use of special instruments and devices. After the execution of every operation follows careful monitoring and testing of the unit or system in action.

An aircraft is considered technically operable when all systems, units, assemblies, instruments, equipment, engines, and airframe satisfy airworthiness standards, i.e., they are able to fulfill their functions in accordance with their rated characteristics.

The system of maintenance of modern aircraft is organized in such a way as not only to reveal and remove the malfunctions

which appeared in the foregoing flight, but also to guarantee that in the next flight malfunctions will not appear. This seemingly simple thought in reality is very complex in its technical execution. Before installing the unit or instrument in the aircraft, they thoroughly investigate, test, and observe the operation of large groups of such units and on the basis of this material tell how long it can work on the aircraft, i.e., they determine its service life.

The technical personnel of civil aviation, studying operating experience, can quite definitely forecast the possibility of the failure of one or the other instrument, unit, or equipment in a forthcoming flight. If on the basis of the forecast there is no confidence that the unit will not be damaged, they replace it with a new one.

There is also another means to the solution of the problem. Every unit (system, unit, part subassembly) has such parameters, observations of which in the process of operation can guarantee operable work in a subsequent interval of time with a high degree of probability. The question is only to correctly determine these parameters and to create technical equipment for their recording and analysis. For clarity let us give an example with a unit, let us say, of the fuel system of the aircraft - the fuel pump. Let us assume that from the very beginning of its operation the vibration level of the housing and the temperature of housing are recorded. If the pump works properly then these parameters will within certain limits be constant. With very rare exeption breakage of a unit does not begin immediately, unexpectedly. Only if we do not watch the unit will its breakage seem unexpected. Actually the malfunction originates considerably before breakage and withdrawal from service of the unit occur. In our example let us assume that the process of the crumbling off of metal from the rotor blades of the pump was initiated. This process is slow and the pump even for a prolonged time can outwardly and

according to characteristics seem operable. But changes in the recorded parameters, for example of the vibration level of the pump casing and the temperature of the housing will be considerable, and long before the breakage of the pump it is possible to determine its malfunction.

This is only a simplified sketch of the complex systems of diagnostics of the technical status of aircraft units, assemblies, and equipment which are being developed and introduced at present.

In the near future such systems will be automated and will make it possible to almost completely eliminate cases of technical malfunction of aviation equipment.

After a determined number of flight hours (for every airplane, helicopter, and aircraft engine the number of hours is established by special documents) an airplane, helicopter or engine must be repaired. Repair consists of dismantling the aircraft (or engine), flushing and cleaning its parts and assemblies, exposing faults and wear, restoration or elimination of malfunctions, assembly, painting, and testing.

This work in civil aviation is conducted at specialized aviation repair plants (ARZ) [AP3]. A modern aviation repair plant is a large industrial type enterprise equipped with modern machine, laboratory and technological equipment.

EDUCATIONAL AND SCIENTIFIC CENTERS OF AEROFLOT

For the accomplishment of the complex objectives confronting Aeroflot, a capable organization of labor, quality maintenance, and repair of aviation equipment requires people with different specialities: pilots and navigators, engineers and technicians, flight control officers, controllers, and many others. The

training of personnel for civil aviation is carried out in the educational institutions of Aeroflot.

The first educational organization, created in the difficult years after the Great October Revolution, was the department of air communications organized in the Petrograd Institute of Railway Engineers on 28 September 1920. In the 10 years of its existence the department was able to prepare those cadres of civil aviation engineers which participated in the founding and organization of the lines of the "Dobrolet" society, and then Aeroflot. They were the first specialists in the building of airfields and the design of civil aircraft. Scientific-educational cadres were also prepared in the department.

The development of the department of air communications made it possible in 1930 to organize on its base the first educational institutions of Aeroflot - the Leningrad Institute of Engineers of the GVF (Civil Air Fleet) (II GVF) - for the training of specialists in all basic branches of civil aviation work.

The development of civil aviation caused the development of a whole network of educational institutions. Besides II GVF, in 1930 the GVF department attached to the Kiev Polytechnic Institute was created from which in 1933 the Kiev Institute of the GVF was formed.

In 1933 on the basis of the unification of the aeronautical department of the Leningrad Institute of Engineers of GVF and the same department of the Moscow Aviation Institute the Moscow Airship Building Institute was organized, in 1939 it was reorganized as the Moscow Institute of Engineers of GVF named after K. E. Tsiolkovsky. Thus, in 1933 civil aviation had technical colleges in Leningrad, Moscow, and Kiev, and also Aviation Higher Academic Courses for the training of the higher supervisory staff of the GVF. Instead of these courses in 1939 the Academy of the GVF was organized in Moscow with that purpose.

In 1931 three united schools of pilots and technicians were organized for the training of flight and middle technical crews in Bataysk, Tambov and Balashov, and also technical schools in the cities of Gorkiy, Saratov, Leningrad, Moscow, Kiev, Valki, and Krasnyy Kut.

The network of educational institutions constantly expanded in proportion to the development of civil aviation.

At present the educational institutions prepare personnel for Aeroflot in 34 specialties and specializations.

Aeroflot met its 50th anniversary with four schools of higher education at its disposal - the Order of Lenin Leningrad Academy, the Order of the Red Banner of Labor Kiev Institute, the Order of the Red Banner Riga Institute named after Leninist Komsomol, and the Moscow Institute. In civil aviation there are also advanced flying schools, flying schools, aviation engineering colleges, and colleges of special services.

Prominent scholarly and highly skilled aviation specialists work in educational institutions: academicians, distinguished workers of science and engineering, Doctors and Candidates of Science, and distinguished pilots and navigators. The academic process is carried out in laboratories equipped with modern equipment, engines, airplanes, and helicopters.

The development of civil aviation is inseparably connected with successes in the field of developing aviation science and industry. During the years of the first five-year plans several scientific research institutes were created in the GVF. In February of 1930 a special subdivision was organized, the goal of which was the development of designs and the construction of an experimental all-metal aircraft. The design group headed by

A. I. Putilov, with the participation of the shops of "Dobrolet" developed the aircraft "Stal'-2" made of stainless steel. Here the method of spot and roll electric welding was developed and applied for the first time. This was a great achievement in the technology of aircraft construction of that time.

On the basis of the "Dobrolet" shops and A. I. Putilov's design group the Scientific Research Institute of the GVF (now GosNIIGA [ГосНИИГА - State Scientific Research Institute of Civil Aviation]) was created on 4 October 1930. Its basic goals are the design, construction, testing, and introduction of new aircraft for the GVF.

For the more successful solution of problems in the design and production of aviation equipment the NIIGVF [НИИГВФ - Scientific Research Institute of the GVF] in 1932 was divided into three independent scientific research institutes: aircraft SNIIGVF [СНИИГВФ - Aircraft Scientific Research Institute of the GVF]; aircraft engines NIIAD [НИИАД - Scientific Research Institute for Aircraft Engines]; communications and signaling NIISSGVF [НИИССГВФ - Scientific Research Institute for Communications and Signaling of the GVF].

In 1933 new scientific research institutes and laboratories were created: an institute of agricultural aviation, a technological laboratory, an aerographic institute, an aeromedical laboratory, and a diesel institute. The basic goal of these institutes in the initial period of their activity was the experimental building of aircraft, engines, and numerous equipment for aircraft and airlines.

From 1936 the design and building of aviation equipment was entrusted to the Main Administration of the Aircraft Industry (GUAP) [ГУАП]. The institutes of Aeroflot were united in the single Scientific Research Institute of the GVF. The united

institute of the GVF was committed to determine the prospects of the development of the GVF, to develop technical requirements for new aviation equipment, to carry out contract acceptance and operating tests of newly introduced aviation equipment, to introduce it on the air lines and in the national economy, and to be occupied with the scientific development of questions of its flight and technical operation.

During August of 1954 NII GVF was reorganized as the State Scientific Research Institute of the Civil Air Fleet. The institute carries out contract acceptance tria. of new jet and turboprop airplanes and helicopters, and then in conjunction with production subdivisions - broad and comprehensive operating tests and the introduction of these aircraft on the air lines.

At present besides GosNII three other scientific research institutes and the scientists of four schools of higher education work on Aeroflot subjects.

The State Research Planning and Scientific Research Institute (GPI and NIIGA) "Aeroproyekt" organized in 1959, solves problems of the scientific substantiation of the development of air lines and airports, capital investments in construction and the effectiveness of their use, planning of airports and their arrangement, technological design and construction of buildings, constructions and airfield surfaces, and the coordinated mechanization and automation of production processes in airports.

The mission of the All-Union Scientific Research Institute for Agricultural and Special Use of Civil Aviation (VNII SKhSP GA) [ВНИИ СХСП ГА] organized in 1964 is the scientific substantiation of the prospects of applying civil aviation in the national economy, the development and implementation of technological methods, and the means of applying civil aviation in the national economy.

Taking into account the large volume of work on scientific substantiation, development, and implementation of automated systems of control of the industrial and economic activity of civil aviation, the Central Scientific Research Institute of Automated Control Systems of Civil Aviation (TsNIIASUGA) [ЦНИИАСУГА] was created in 1971.

The direction of the works of the institute is the development and introduction in civil aviation of automated systems of control of the industrial and economic activity of civil aviation.

In the Kiev Institute of Civil Aviation Engineers the development and introduction in civil aviation of new automated air traffic, navigation, and landing control systems, new aviation trainers, methods to increase the technical life of engines and electronic special equipment and radio electronics systems, methods and organization of repair, and automated system of control of the activity of the territorial administration of civil aviation is conducted.

The scientists of the Riga Institute of Civil Aviation Engineers are occupied with the development of promising types of aircraft, aircraft engines, airborne radio equipment and its technical requirements; with the development and the implementation of new methods and equipment, with the evaluation of reliability and durability and safe life.

In the Academy of Civil Aviation the development and introduction in civil aviation of new and more ideal methods and means of flight operation for an increase in the safety and regularity of flights is carried out.

THE BASIC SCIENTIFIC PROBLEMS

Civil aviation of the USSR today is a large branch of the national economy which is being constantly and rapidly developed. The main task of civil aviation is the maximum satisfaction of the population of the country in air transport, the national economy in providing aviation service with high safety, regularity, and economy of flights. This determines the main scientific problems of civil aviation.

The first problem is the creation of new airplanes and helicopters. At present the creation of an aircraft begins long before the designers start work on it. In the beginning it is necessary to determine what kind of aircraft is needed, where it will be most effectively applied, which should be its main characteristics - passenger capacity, speed, range, takeoff and landing properties, efficiency, etc.

The scientists and engineers of the scientific institutions of civil aviation perform this work. They perform analysis of statistical data on transportations of passengers and cargo and on the execution of other aviation works, determine the predictions of passenger and cargo flows and spheres of the use of aviation for many years ahead, consider the tendencies of the development of aviation transport in the unified transport system of the country, and consider the experience of aeronautical development abroad. On the basis of these materials the main characteristics of perspective airplanes and helicopters are determined. In order to begin to design an airplane or helicopter it is necessary to have the technical requirements for them. The technical requirements are also developed by civil aviation specialists. For this the rich operating experience of both domestic and foreign aircraft, the results of special investigations, and the achievements of science and engineering are utilized. The technical requirements are the basis on which the design and building of an aircraft

begins. The aviation designer must, utilizing his experience, design and construct an aircraft which would maximally satisfy the technical requirements.

The aircraft is designed and built. Now begins the work of the civil aviation specialists. It is necessary to conduct a large complex of tests in order to be convinced of the suitability of the aircraft for operation. In the process of tests the aircraft is worked on, all its features are studied, and on the basis of this the air technical orders are developed which the pilots, engineers, technicians, and everyone who will operate this aircraft will use. And then, as long as the aircraft lives in civil aviation they will study and improve it.

Another problem of civil aviation is development of the technical and organizational methods which would make it possible to more effectively utilize the available airplanes and helicopters. Here are solved the complex questions of the organization of maintenance and repair, flight operation, passenger service, processing of cargo, new methods of applying aviation in the national economy, etc. These questions are solved by the scientists, engineers, pilots, and other specialists of civil aviation. Operating experience is generalized, investigations are conducted, engineering calculations are made, and everything is directed so that the airplane or helicopter would fly more, would have a large safe life, and every flight would be made with the maximum effectiveness. In this case the labor productivity of all who provide for flights must be increased, and so-called unproductive expenditures must be maximally reduced.

The modern equipment of civil aviation is not only the airplane and the helicopter, but also many other technical means of mechanization and automation of different production processes. Without such means, of course, one must fail not only to increase the effectiveness of the use of aviation, but also simply to fly.

There are different special machines for the maintenance of aircraft, passenger information equipment, devices for loading and unloading baggage, equipment for managing runways, and finally complex airfield equipment to provide for takeoff, landing, and air traffic control.

The third problem of civil aviation is the development and implementation of the means of complex mechanization and automation of production processes (including the process of takeoff, landing and air traffic control). This is a very large and complex technical problem which is being solved by all of the scientific institutions of civil aviation and by the specialists of operational enterprises. A number of ministries and departments of the country are occupied with the manufacture of such equipment for civil aviation. With every year there is more such technical equipment, manual labor is displaced, labor productivity is increased, and the standard of passenger service is increased.

Civil aviation today is a very complex industry which has many enterprises and organizations and is saturated with modern technology. Questions of rational control of this industry are first of all questions of efficiency, safety, standards of maintenance, etc.

The Party and government give exceptionally great attention to increasing the effectiveness of control of the national economy. In the Directives of the XXIV Congress of the CPSU it was pointed out that the perfection of control of the national economy is the main lever for increasing the economic effectiveness of the national economy and, consequently, also the welfare of the people. In the materials of the Congress are given the means to the solution of these questions - the wide implementation of automated systems of control on the basis of economic and mathematical methods with the use of electronic computer technology.

The scientists and engineers of civil aviation are now developing and introducing a series of automated systems which on their completion will give the possibility of controlling industry and individual enterprises with the use of electronic computer technology.

Even now a series of subsystems function including aircraft schedule compilation, material and technical supply, and the planning of work of a series of enterprises. The effect of the implementation of these subsystems is great.

The effectiveness of the use of electronic computer technology in civil aviation is felt not only by the specialists, but also by the passengers. In the summer of 1972 the first stage of the automated ticket sale and reservation system started operation for the Moscow network "Sirena-1". Specialists of the Ministry of Instrument Making and Means of Automation created this system. In the near future other automated control systems will be created.

Flights at high speeds present exceptionally high requirements both for aviation technology and for people who manage this technology. Among all problems solved by the specialists of civil aviation there is one which in its essence is most important - the development of methods and means which ensure complete flight safety.

When solving all scientific and technical problems of civil aviation, the specialists always first of all proceed from the main principle - the insuring of flight safety. Whether new airplanes and helicopters are created or new organizational forms are introduced in all cases the questions of flight safety are foremost. Along with this there are special problems on the way to increase flight safety.

Let us take, for example, the work of the crew on the flight deck of a modern aircraft. The distribution of responsibilities between the members of the crew during the different phases of flight, their interaction between themselves, the interaction of the crew with ground-based services - this is by no means a full enumeration of the questions which must be solved during the investigation of a flight safety problem. But this is only one part of the questions. Another and no less important is the interaction of man with the cabin equipment (with instruments, controls, various kinds of indicators, signal indicators etc.). The ability to correctly and rapidly accept information from the instruments depends not only on the individual abilities of the man (by the way, this is also an interesting area of exploration of flight safety), but also on the arrangement of the instruments, their color, form, cabin lighting, and other factors. But where is the saturation point of the cabin by different instruments? How long can the pilot work normally?

Let us take another example. The aircraft must fly in any weather. It must, but sometimes cannot because of flight safety conditions. It cannot because in the zone of thunderstorm activity the aircraft can hit strong turbulent flows. How can this be avoided? Special investigations are carried out, as a result of which dangerous zones are defined and the crew is previously forewarned before takeoff and thus they plot the flight course outside these zones. This is also the object of the research of the science of flight safety.

The enumerated problems do not exhaust all the subjects of scientific investigations. But all problems and all questions solved in the civil aviation today are directed to one purpose - to fly safely, regularly, economically, and with great benefit for the national economy of the country.